

# Recent Space Weather Activities and Plans in the UK

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# Government interest

- Space weather fits agenda on security & resilience
- Considered in National Risk Assessment
  - discussions started May 2010
  - Space Environment Impacts Expert Group formed Nov 2010
  - SEIEG provides independent scientific advice, much appreciated by policy-makers
  - strong emphasis on (peer reviewed) scientific evidence
  - Space weather risk formally recognised with publication of NRR in Jan 2012

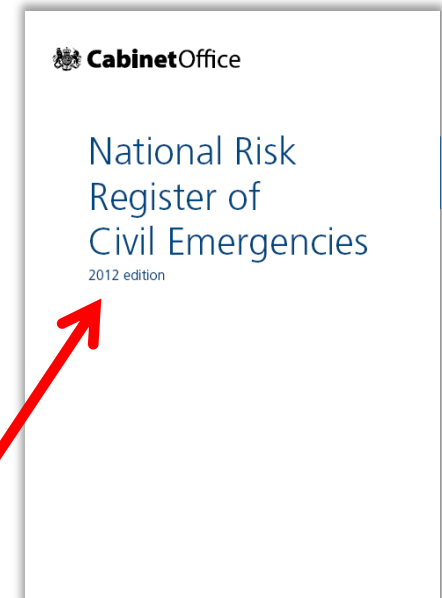


Figure 2: Risks of natural hazards and major accidents



## NRR risk matrix non-malicious risks

Impact score based on

- Fatalities
- Injuries/illness
- Social disruption
- Economic harm
- Psychological impact

<http://www.cabinetoffice.gov.uk/resource-library/national-risk-register>

# Next steps

- NRR recognises space weather is young field
  - So significant work still needed
- To better understand impacts of a severe event:
  - More detailed assessments, especially power grid
  - Where are knowledge gaps?
  - Raise awareness across government, industry, media
  - Feed into National Space Security Policy
- And to plan for those impacts
  - How to respond to a major event
  - What monitoring & forecast capabilities are needed

# Parliamentary interest

- Space weather included in 2 recent inquiries by House of Commons committees
  - Science & Technology Comm: Use of scientific evidence in emergencies, report Mar 2011, <http://tinyurl.com/d2py3sz>
  - Defence Comm: Developing Threats: Electro-Magnetic Pulses (EMP), report Feb 2012, <http://tinyurl.com/7slanzh>
  - Both included written & oral evidence from researchers, industry and government
  - Supportive of efforts to improve understanding & mitigation
- 3<sup>rd</sup> International EIS Summit to be held at Parliament:
  - 14-15 May 2012, <http://www.eissummit.com/>

# Professional activities

- *Geomagnetically induced currents in national power grids*
  - Workshop at Lancaster University, 30-31 March 2011
  - EPSRC impact money: engage research, industry & government
  - Model for future UK activities (see later)
- *Space weather: impacts on engineered systems, infrastructure & society*
  - Royal Academy of Engineering study, <http://tinyurl.com/burj2xy>
  - in progress under lead of Paul Cannon, report due in autumn
- *Space climate impacts: the past, present and future*
  - Workshop at University of Leeds, 13-14 June 2012
  - space weather impact of changing internal geomagnetic field
- *Predicting and protecting against geomagnetic storms*
  - IET seminar on solar storms, [www.theiet.org/solar-storms](http://www.theiet.org/solar-storms)
  - London, 28 September 2012

# US/UK workshops

## **Science Predicting and Protecting Against Space Weather Events:**

The U.S. and UK continue to build a close partnership to understand atmospheric dynamics and monitor and model space-weather events. Following last year's commitment to collaborate in this domain, the two countries held one workshop in 2011 and another is planned for 2012 to further integrate U.S. and UK expertise and develop relevant policies. The U.S. will continue to work with the UK in the development of a real-time UK operational space-weather service. These joint actions will lead to improved forecasting capabilities to mitigate damage to our electric power infrastructure and disruptions to GPS-enabled capabilities.

*14 March 2012*

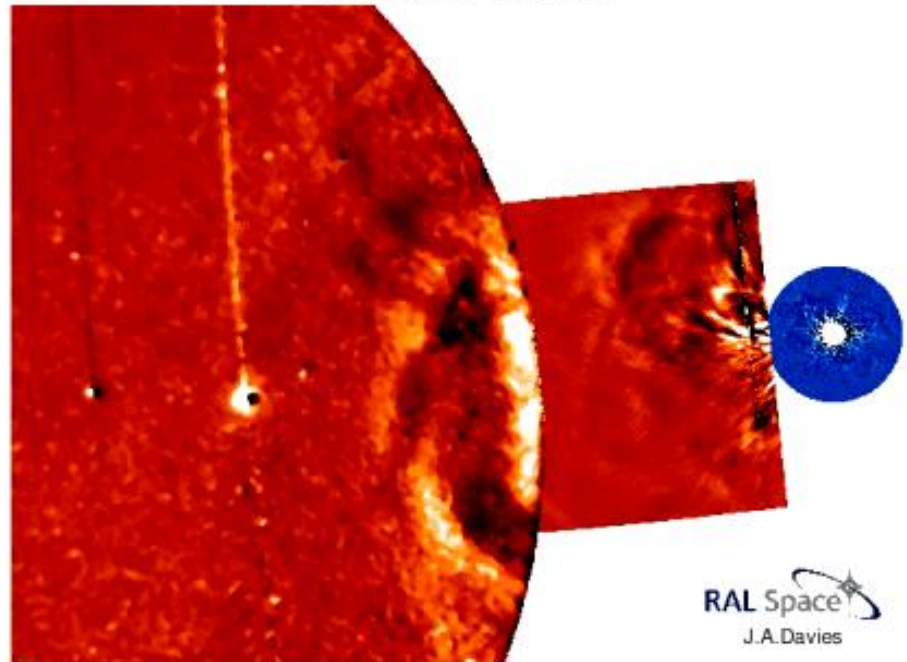
- Thermosphere/Ionosphere: use of physics-based models
- Building Whole-Atmosphere-Models

# Space sensor technologies

*For example:*

- High-res space cameras (RAL) => *solar disc/CME*
  - STEREO (HI, EUVI, COR), SDO (AIA, HMI), SMEI, GOES
- Energetic particles (MSSL, RAL) => *bulk plasma + suprathermal*
  - ESA HMRM, Solar Orbiter, KuaFu?
- Magnetic field (ICL)
  - Solar Orbiter, cubesat

STEREO-A/SECCHI  
2012-03-06 00:00UT





# Missions & concepts

- UKube-1 - cubesat to fly in 2012: GPS TEC (TOPCAT) will support tomographic study of ionosphere & plasmasphere
- TRIO-CINEMA - magnetometer on Korean-led cubesat: mapping ULF waves in LEO
- HAGRID - study for operational mission for Heliospheric Imaging (lessons learned from STEREO) – see poster here
- Solar sail - studies at Strathclyde include sub-L1 solar wind monitor
- Space weather diamond - MSc project team at Cranfield analysing at Chris St Cyr's concept for sub-L1 mission

# Ground sensor technologies

*For example:*

- Operation and development of SuperDARN systems
- Looking at use of phased array technologies for next generation:
  - incoherent scatter, riometer, etc
  - synergy with radio astronomy - image shows UK LOFAR site
- Prototyping for low-cost COTS-digital ionosonde



# Space weather modelling

Key space weather projects include:

- Ionosphere-thermosphere-plasmasphere physics models (Met Office, UCL, Bath)
  - Key target for UK-US collaboration (Met Office/SWPC)
  - FP7 ATMOP project on atmospheric drag
  - Exploits Bath MIDAS assimilation model
- Assimilative ionospheric model (QinetiQ)
  - In operational use for MoD strategic comms
- Radiation belt modelling (BAS)
  - FP7 Spacecast project
- Internal geomagnetic field, including IGRF (BGS)
  - Essential and evolving component of many other models
- Automated Solar Activity Prediction Tool (Bradford)
  - In use at NASA/CCMC

# Research programmes

- Funders for space weather research
  - NERC – impact on Planet Earth – classic STP
  - STFC Astronomy programme – solar/heliosphere/space plasma
  - UKSA - space mission build & operations
  - EPSRC – if clear engineering impact
- STFC Futures programme
  - Encouraging space weather as environment issue (link to NERC)
  - Space weather network proposal SEREN just submitted – to build up links between research, industry and government
- NERC Natural Hazards theme
  - Developing proposal for substantial programme on space weather
  - How to partner with STFC?
- Strategy/programme reviews at NERC and STFC due soon

# Research centres



# Public engagement

- Already much good work here
  - Scientists engaging in many fora
  - Web projects, e.g. Solar Storm Watch, AuroraWatch UK
- But increasing need to raise game further
  - Awareness raising prior to events
  - Network of experts ready to respond quickly
  - Deal with media hype
  - Openness is vital – competing with many other news sources
  - Engage on social as well as mainstream media
  - Encouragement from Government
- Bid for Sciencewise money for public dialogue
- Media engagement as part of SEREN network

# European dimension - ESA

- Solar Orbiter now approved
  - science mission to study sources of solar wind, UK teams lead on spectrometer and in-situ plasma measurements
- SWARM to launch in July 2012
  - EO mission to study mag field, strong UK science interest
- KuaFu proposal under study
  - ESA-China mission to study response of magnetosphere-ionosphere to solar wind (biggest hole in space weather science?)
- SSA programme
  - ESA developing plans for 2013 onwards
  - Discussing alignment with UK interests

# European dimension - EU

- Framework 7
  - UK groups in many space weather projects funded by FP7
    - under variety of calls (space science, infrastructure, space asset protection, training networks, ...)
    - Projects with major UK roles include ECLAT, HELIO, ESPAS, Spacecast, EURISGIC, TRANSMIT, ...
    - Now looking at/lobbying plans for FP7 Space call due out in July
- Horizon 2020
  - New name for FP8 – runs from 2014
  - Some lobbying for space weather – need more!