UK Space Weather Strategy
linking research to operations

Mike Hapgood (STFC), John Rees (NERC),
Chris Felton (CCS) & Alan Thomson (NERC)

(mike.hapgood@stfc.ac.uk)
Outline

The work of the Civil Contingencies Secretariat
• Cabinet Office – at the centre of UK government
• CCS work on space weather

How the UK Space Weather Strategy has evolved
• Background
• Relation to the UK government National Risk Register
• Building the strategy
• http://tinyurl.com/coxc4le

Royal Academy of Engineering report
• “Extreme space weather: impacts on engineered systems and infrastructure”
• www.raeng.org.uk
The work of the Civil Contingencies Secretariat

- Short-term horizon scanning and medium term risk assessment
- building capability
- ensuring consistency
- critical infrastructure
- **planning for the big stuff**
- supporting community and corporate resilience
- .......and dealing with it when it goes wrong
Building resilience: approach

- Top risks on the National Risk Assessment have high likelihood and high impact and range from a flu pandemic, to terrorism, to an ash rich volcanic eruption abroad
- Also focus on lower likelihood, high impact risks: severe space weather and gas-rich effusive volcanic eruption
- Risk assessment and planning based on ‘reasonable worst case scenario’
- Generic capabilities built through the National Resilience Capabilities Programme provide a baseline of capability for these risks, however more focussed planning is required to:
  - develop additional capability / capacity; and / or
  - develop bespoke capabilities to meet the specific consequences
- Our approach to high impact risks involves working with Government Departments, operational agencies and external experts to develop specific contingency plans
Background to UK work on severe space weather

- Space weather fits in national agendas on security & resilience: UK, US, Sweden, …
- UK National Risk Assessment
  - Space weather discussions started May 2010
  - Space Environment Impacts Expert Group formed Nov 2010
  - SEIEG provides independent scientific advice, much appreciated by policy-makers
  - Emphasis on (peer reviewed) scientific evidence
  - Space weather risk formally recognised with publication of NRR in Jan 2012
  - SEIEG extreme cases now available as RAL technical report: http://tinyurl.com/czejfnz

With added space weather & volcanoes
### NRR risk matrix

**Non-malicious risks**

Impact score based on:
- Fatalities
- Injuries/illness
- Social disruption
- Economic harm
- Psychological impact

**http://tinyurl.com/cycruu7**

or

Resilience planning challenges

- Nature of underpinning science means there’s greater uncertainty about reasonable worst case scenario compared to other risks on National Risk Register and limits our ability to forecast and model impact.
- Getting buy in to lower likelihood risks.
- Interdependence of potential impacts presents high level of complexity in providing resilience.
- Effective communication co-ordinated internationally, both to industry and the wider public, vital to prepare effectively for this risk.
- Very short notice were a major event to happen.
- Impact would be felt internationally. Therefore, international collaboration vital to build resilience.
Resilience planning update

- Lot of work to understand the nature of this risk for the UK since it first appeared in National Risk Assessment in 2011.
- Met Office ‘own’ this risk. Lead departments responsible for mitigating the impacts. Co-ordination provided by CCS in Cabinet Office.
- Severe Space Weather Project set up in CCS. First project board meeting, 23 April co-chaired by Met Office and CCS.
- Accountable to High Impact Hazards Programme Board as part of National Security Council structure. First meeting on 29 April. Chaired by Director, Civil Contingencies.
- Expert Advisory Group (based on the SEIEG) being set up as formal part of governance to ensure the work of the project is informed by scientific evidence.
- Continue international collaboration (US, Sweden, Canada, JRC).
- Main outputs: enhanced capabilities to be reflected in response strategy for responding to a severe space weather incident.
Building the strategy

• Aims: how best to link research to operations (R20)
  – Put this in national and international context

• Process
  – Collected evidence from wide range of national and international sources (next slide)
  – Constructed first draft for review by selected colleagues
  – Showed need for major restructuring
  – New draft reviewed by expert community
  – Then a series of updates and public reviews
Landscape – key points

- FCO S&IN
- National Risk Assessment
- SEIEG
- Lloyds report
- Met Office
- Cameron-Obama statements
- HoC committees
- EIS meetings
- GIC and geomag meetings
- UKSA
- STFC SSAP
- RAEng report
- GO Science
- NERC
- STFC
- Community consultations
- Strategy (R20)
- UK-US meetings
Why a strategy?
Link all UK players from R20
Put UK work in global context

Governance framework

What are risks & impacts?
National Risk Register
Outline sectors at risk
Businesses

Focus first on need for mitigation of risk
Then on relevant science – so science flows from needs

Space weather service
Analysis of markets
Monitoring
Modelling

Trace from impacts so we engage wider community,
(scientists prefer to trace the energy flow)

Magstorms & the Sun's high-speed streams
Radiation, solar cosmic rays
Solar electromagnetic emissions
Climate
Earth's internal field
Space weather processes
Magstorms & their solar origin
High-speed streams
Radiation storms, Cosmic rays
Solar electromagnetic emissions
SpW & Earth's climate
SpW & Earth's internal field

Research & Operations
By risk sector: grounded infrastructures, aviation, satellites, radio
Cross-cutting themes: heliosphere, magnetosphere, ionosphere-thermosphere, internal mag field, economic & societal impacts

Implementation & organisation
Governance: Strategy Board
Investment: Strategy essential both to win support & to be efficient
Web: to maintain & evolve the strategy, and associated resources

Details in annexes
UK skills, meetings, participants, documents

From UK-US w’shops, updated after review

Governance is key
Where is it?

UK Space Weather strategy - linking research to operations

This strategy aims to provide a cross-organisational framework to support space weather research and operations in the UK – in particular better linking research to operational activities and through to stakeholder requirements. It has developed from community-led activities involving both NERC and STFC and integrates research and operations. It is intended that this will feed into on-going NERC and STFC processes.

In particular, the Strategy builds on a series of discussions involving many UK experts:

- A UK-US space weather Research Workshop in Boulder, Colorado, on 11-13 October 2011;
- STFC Environment Futures workshop at the Open University, 26-27 October 2011, included space weather as one of six potential themes for joint work by NERC and STFC communities;

http://www.ukssdc.ac.uk/twiki/bin/view/UKUSSpaceWeather/SpaceWeatherstrategy

Or

http://tinyurl.com/coxc4le

© 2013 RAL Space
Extreme Space Weather: Impacts on Engineered Systems & Infrastructure

Prof. Paul Cannon, FREng
Royal Academy of Engineering
Study Chair

Plus a very extensive team of space scientists and engineers

(Credit: NASA)
The full report can be downloaded from:

A summary report can be downloaded from:

Recommendations (e.g. p6 of summary):
• Government should initiate a space weather board to provide leadership in SW activities
• UK should work with international partners to refine the environmental specification of extreme solar events and reasonable worst case scenarios
• Specific recommendations are made on protection/research against worst case scenarios in sectors covering grid, satellites, aviation, ground and avionic technology, GNSS, terrestrial mobile, HF and broadcasting communications