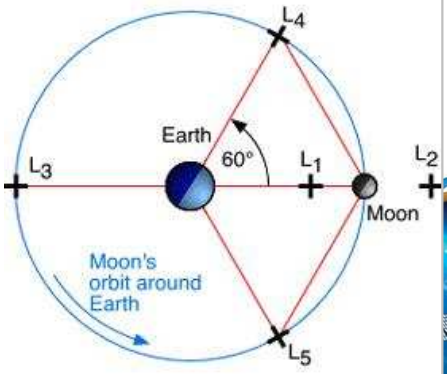
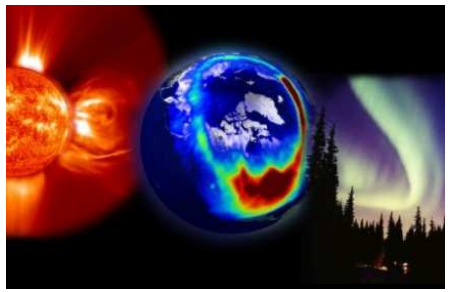


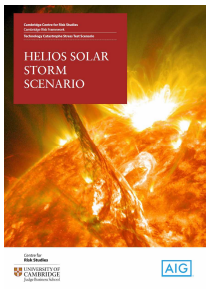
Science & Technology Facilities Council
10 Years of Impact and Inspiration

UK Risk Assessment and Economic Impact Study

Mario M. Bisi (STFC RAL Space, UK) {Mario.Bisi@stfc.ac.uk}.

Inputs from: Ed Oughton (University of Cambridge, UK),
Mark Gibbs and Catherine Burnett (Met Office, UK),
Mike A. Hapgood (STFC RAL Space, UK), and
Enrico Biffis (Imperial College, London).

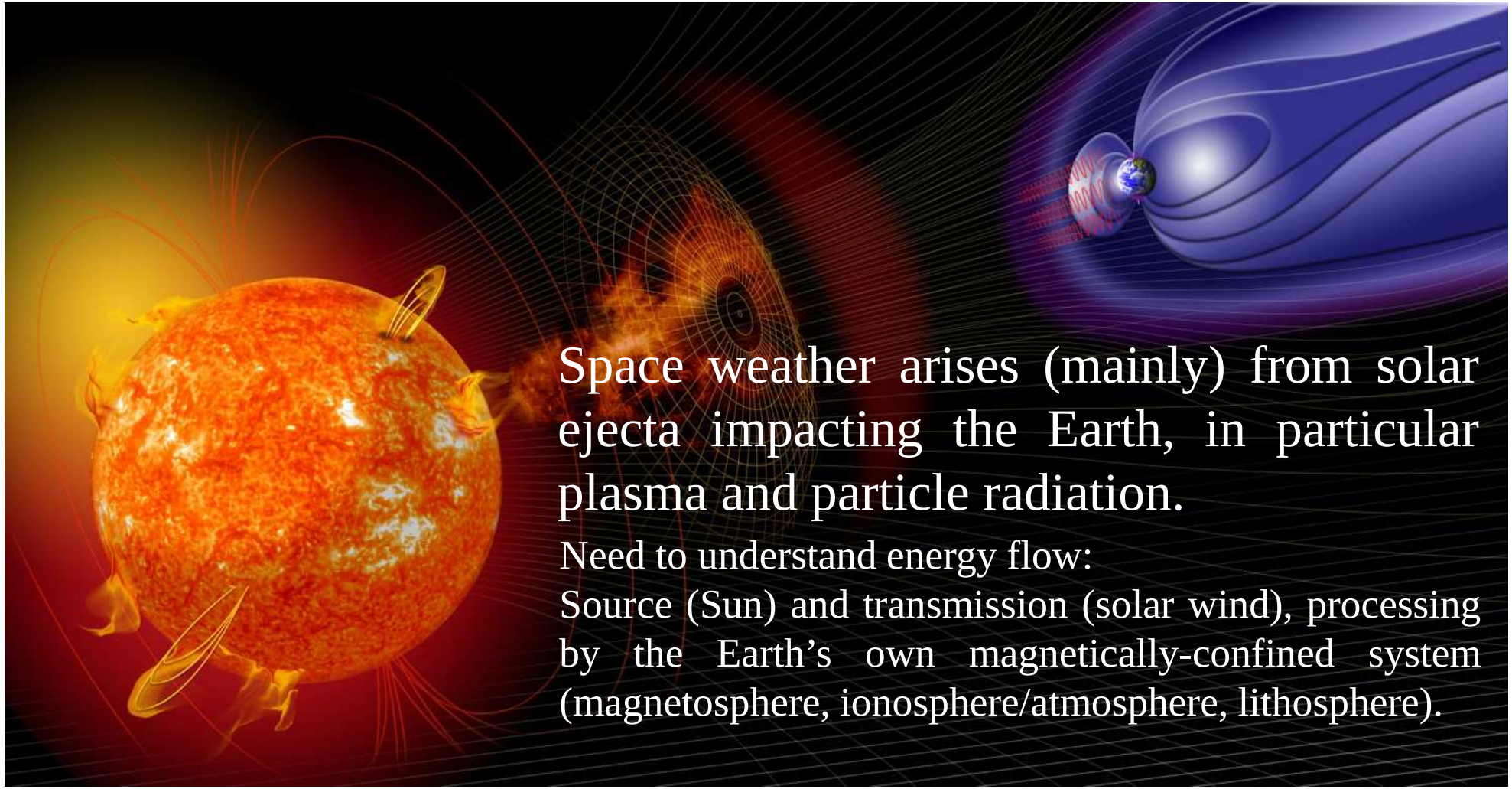




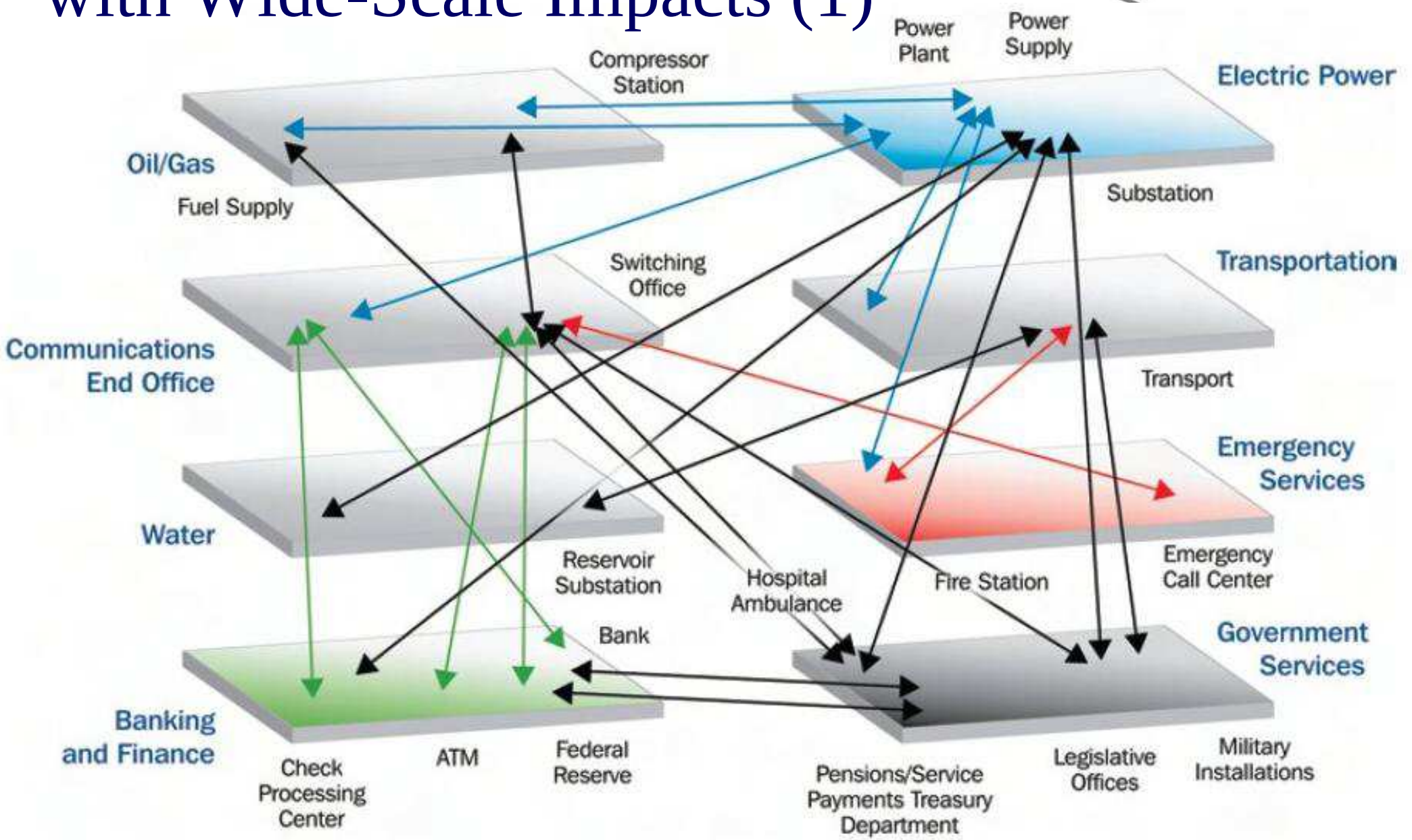
RAL Space

Caveat

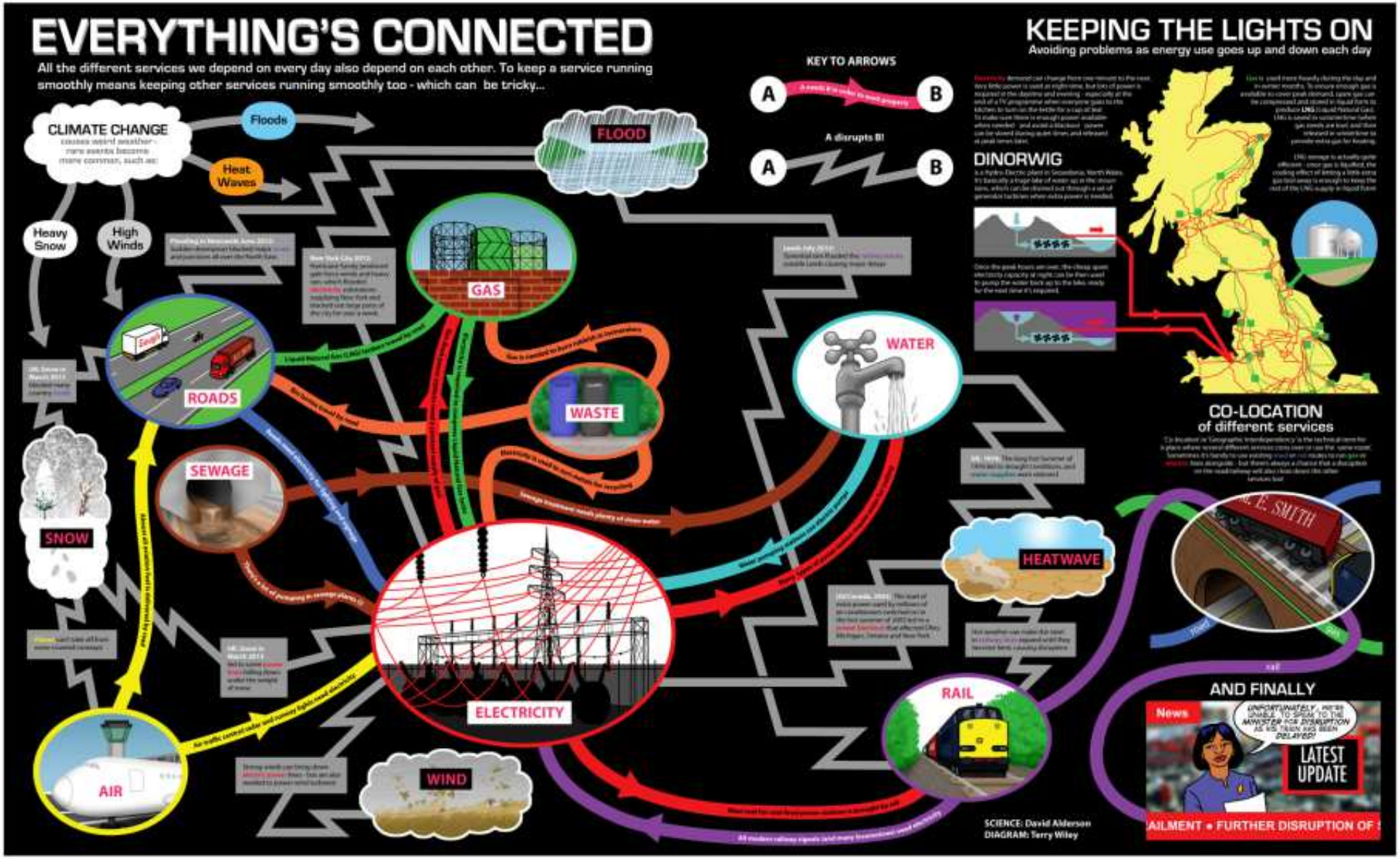
Space-Weather Focus (why does the UK care?): The Sun-Earth Connection

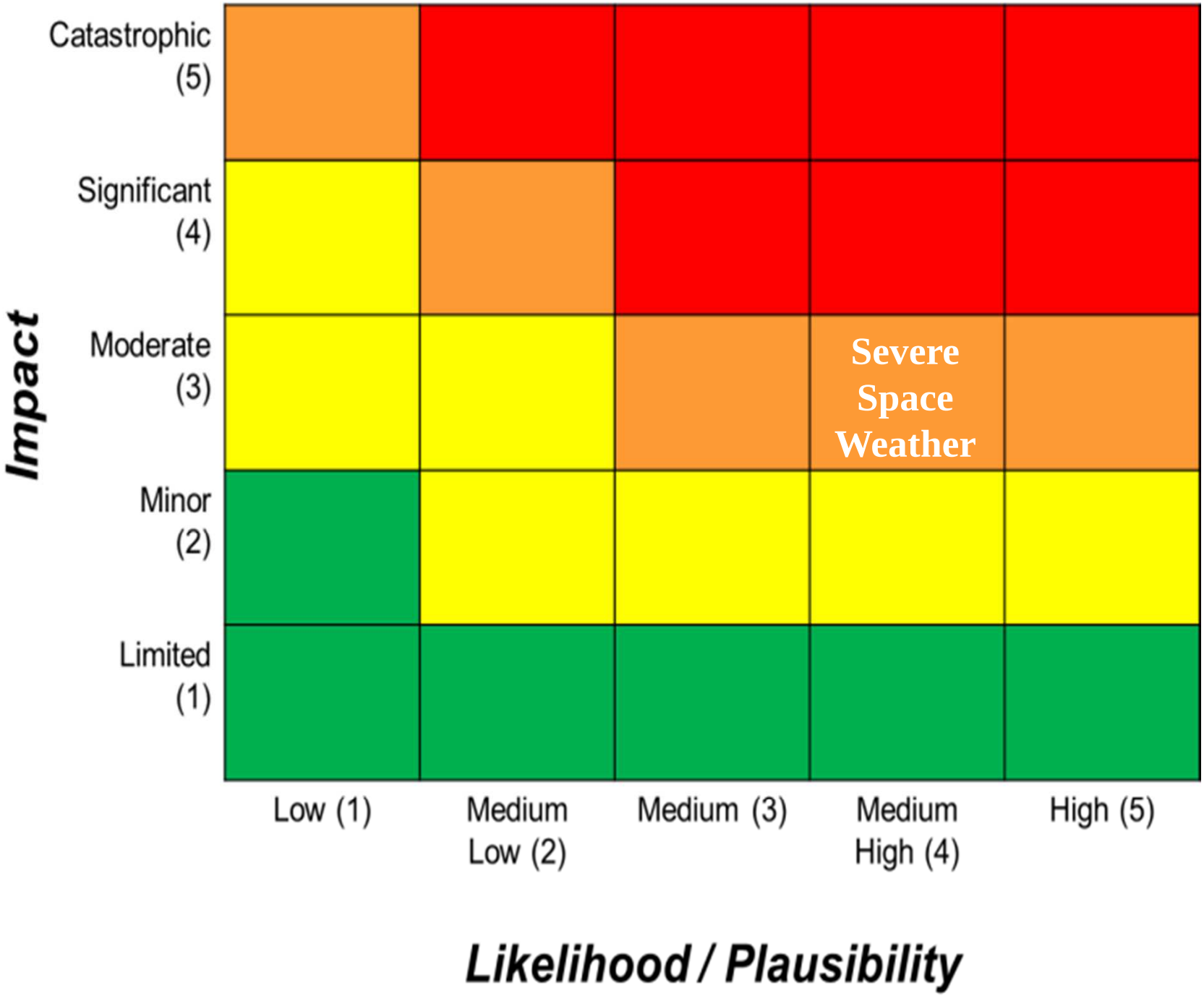


Interconnected Systems with Wide-Scale Impacts (1)



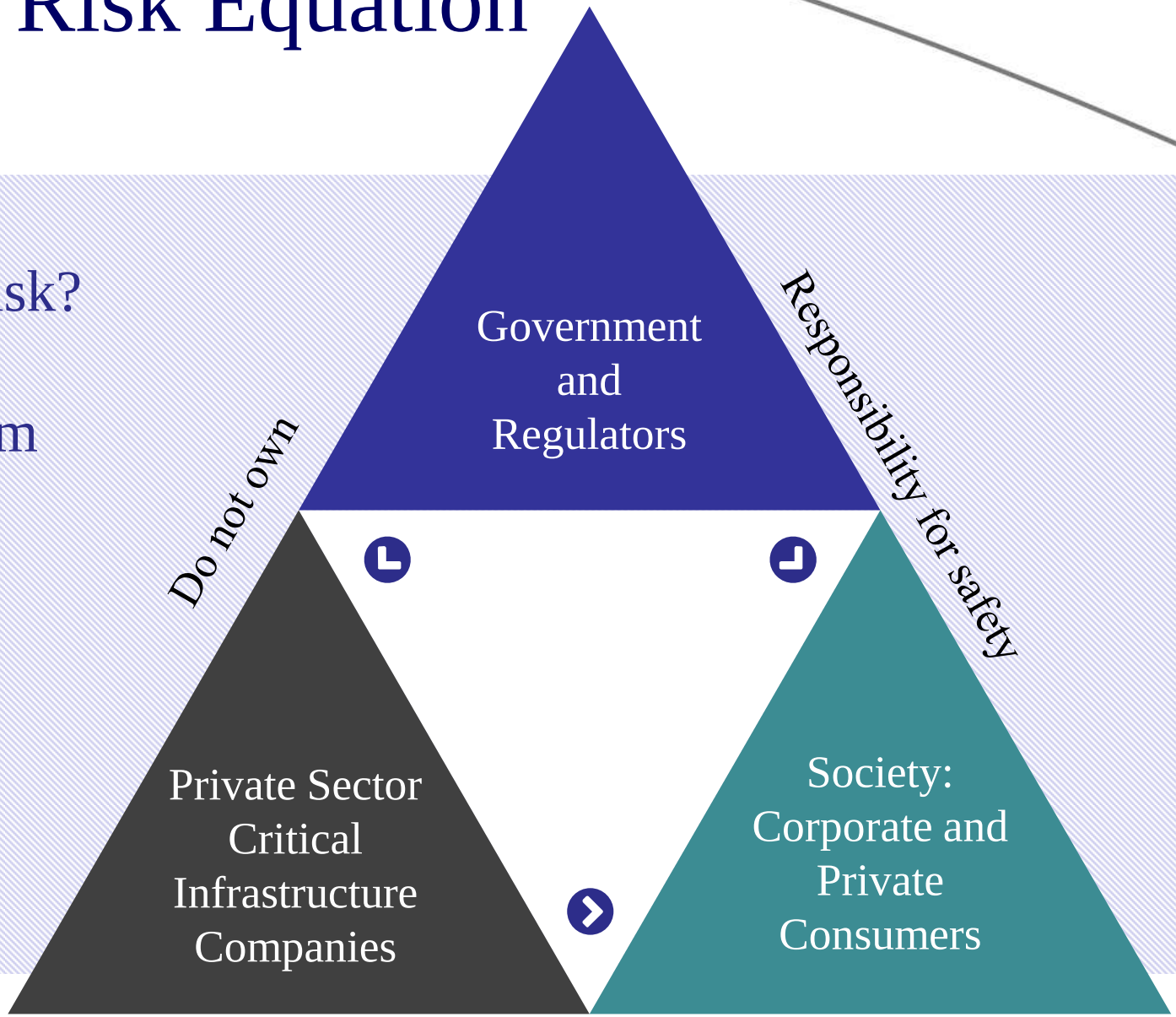
Interconnected Systems with Wide-Scale Impacts (2)




Catastrophic (5)
Significant (4)
Moderate (3)
Minor (2)
Limited (1)
Impact
Severe Space Weather
Low (1)
Medium Low (2)
Medium (3)
Medium High (4)
High (5)
Likelihood / Plausibility

Optimising the Risk Equation

- Who Bears the Risk?
- Who Benefits from Resilience?



Socio-Economic Studies (1)

- UKSA IPSP Study undertaken with substantial results in favour of needing increased forecast capability, not just in maintaining the status quo:
  - Started with a literature study later published (see: Eastwood *et al*., Risk Analysis, doi:10.1111/risa.12765, 2017);
  - Included comprehensive space-weather sub-storm impact studies based on historical severe geomagnetic storms of varying impacts (1-in-10, 1-in-30, 1-in-100 year cases);
  - Included comprehensive studies on both the power grid and aviation sectors ONLY;
  - Many learning outcomes on how we improve the studies, to look at the wider (secondary impacts and quantify them), and how we tackle other sectors similarly/differently…

Socio-Economic Studies (2)

- UKSA IPSP Study economic approach:
  - Footprinting - Physical footprinting, impact table, resilience table, and evidence on comparative man-made (explosion, fire, terrorism) and natural (windstorms, quakes) impacts;
  - Bottom-up analysis - Value of Lost Load (VoLL) emerging across the footprint (timestamp, location, severity, and duration of sub-storm), and physical damage and business interruption; and
  - Spillovers - International spillovers via Input-Output (I-O) Model, and reallocation of costs across countries and sectors.
- Looked at three types of recovery to severe space-weather events: Immediate recovery; No recovery; and Linear recovery.
- ***In a reasonable worst-case scenario, losses up to €5B expected.***

Socio-Economic Studies (3)

- The University of Cambridge EPSRC study concentrated on quantifying the daily economic impact of extreme space weather due to failure in electricity transmission infrastructure:
  - Concentrated on the US grid infrastructure and regionalised:
    - Focus was on the USA for a number of reasons including absolute economic size, insurance penetration, regulatory emphasis, *etc*…; and
  - Can learn how to apply similar studies to Europe and UK.
- Daily economic losses depending on the severity of the event (how far South it reached across the continental USA states) ranged from $7B per day to $48.5B per day as total combined direct losses in the USA and globally including both upstream and downstream effects.


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

If you want to know more…

- Please contact myself (*Mario.Bisi@stfc.ac.uk*), Mark Gibbs (*Mark.Gibbs@metoffice.gov.uk*), Ed Oughton (*e.oughton@jbs.cam.ac.uk*), Catherine Burnett (*Catherine.Burnett@metoffice.gov.uk*), or Mike Hapgood directly (*Mike.Hapgood@stfc.ac.uk*).

- Also, please see session **SH012** at the upcoming **Fall AGU** in New Orleans in December of this year "*Space Weather Forecasting: Science, Operations, Future Missions, Missing Information, and the Economic Case*" **– abstract-submission deadline of 2nd August (Wednesday!)**: https://goo.gl/6QqYft or https://agu.confex.com/agu/fm17/preliminaryview.cgi/Session23441