



Helios Solar Storm Scenario
3 November 2016

Perspectives on Solar Storm Risks

Centre for
Risk Studies



UNIVERSITY OF
CAMBRIDGE
Judge Business School

Simon Ruffle
Director of Research and Innovation
Cambridge Centre for Research





The Auroral Display in Boston.

Boston, Friday, Sept. 2.

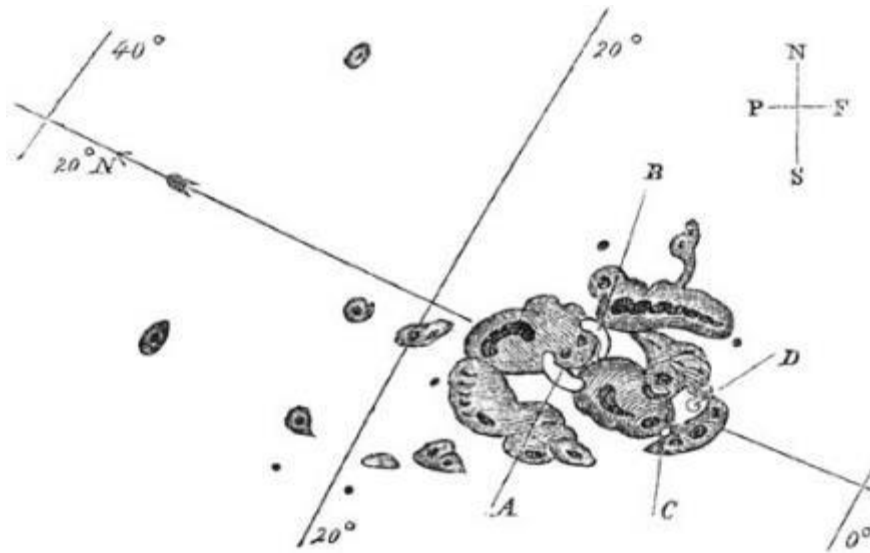
There was another display of the Aurora last night, so brilliant that at about one o'clock ordinary print could be read by the light. The effect continued through this forenoon, considerably affecting the working of the telegraph lines. The auroral currents from east to west were so regular that the operators on the Eastern lines were able to hold communication and transmit messages over the line between this city and Portland, the usual batteries being discontinued from the wire. The same effects were exhibited upon the Cape Cod and other lines.

The New York Times

Published: September 3, 1859

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The 1859 Carrington Event



The Telegraph System

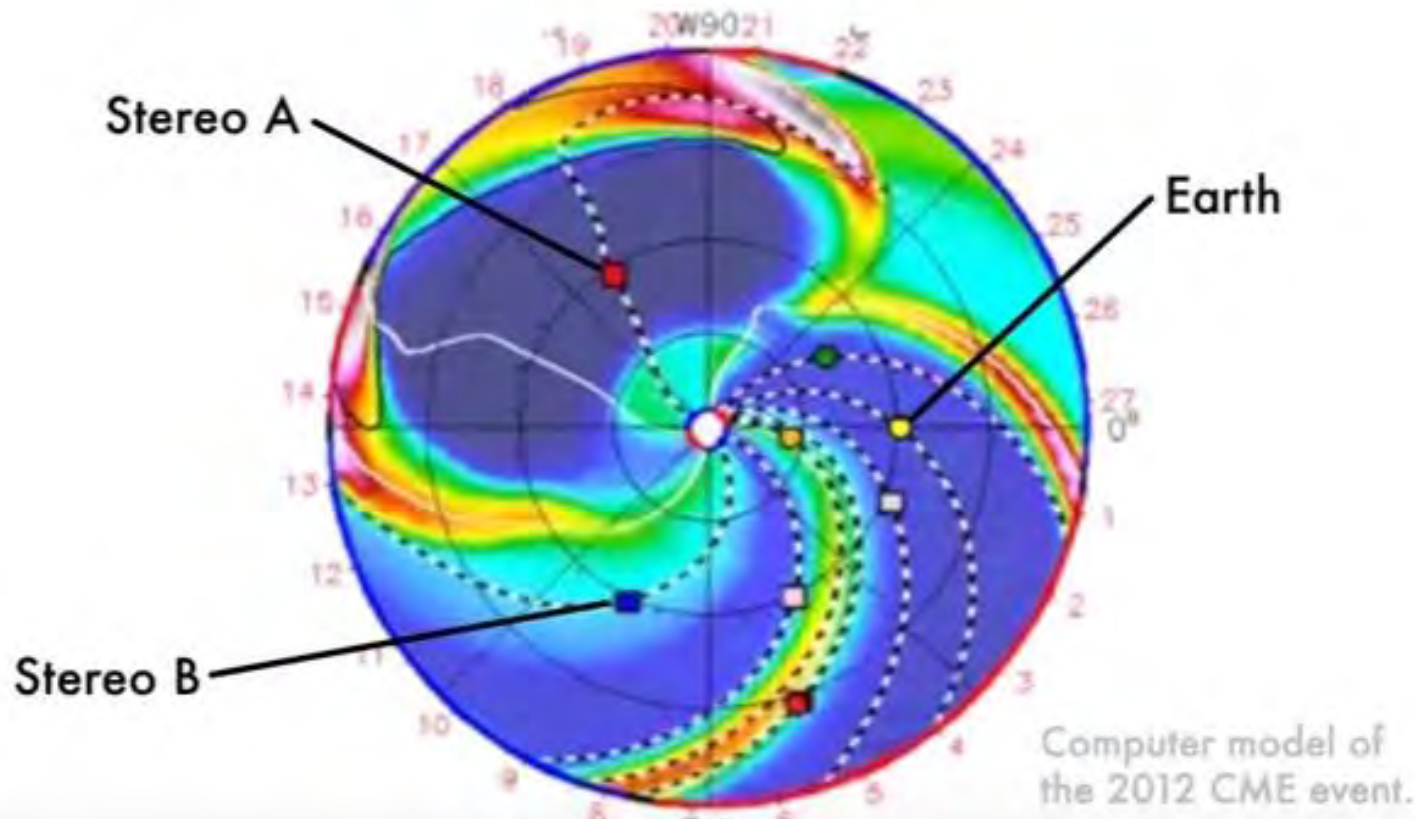


THE OVERLAND PONY EXPRESS.—[PHOTOGRAPHED BY SAVAGE, SALT LAKE CITY, FROM A PAINTING BY GEORGE M. OTTINGER.]

After Carrington



23rd July 2012 Coronal Mass Ejection



Credit: NASA Space Weather Research Center

EHV Transformers are Vulnerable, and Big



Cambridge Centre for Risk Studies



Research Supporters and Academic Collaborators:

McKinsey & Company

HSBC

LOCKHEED MARTIN



TALBOT
VALIDUS GROUP

AIG

XL
XL CATLIN

LLOYD'S

Munich RE

Willis
Towers
Watson

POOL RE

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Centre for
Risk Studies

Research Focus: Catastrophic Failures of Complex Systems

- The Centre for Risk Studies arises from shared interests by the participants in exploring areas of intersection between
 - Catastrophe modeling and extreme risk analytics
 - Failure of complex systems and networks
- We estimate how catastrophes impact:
 - The Global Economy
 - Industry Sectors
 - Financial Markets
 - The Insurance Industry
- Advance the scientific understanding of how systems can be made more resilient to the threat of catastrophic failures

Cambridge Taxonomy of Threats

Financial Shock



FinCat



Asset Bubble



Financial Irregularity



Market Crash



Sovereign Default



Bank Run

Trade Dispute



TradeCat



Labour Dispute



Trade Sanctions



Cartel Pressure



Nationalization



Tariff War

Geopolitical Conflict



WarCat



Conventional War



Asymmetric War



External Force



Civil War



Nuclear War

Political Violence



HateCat



Terrorism



Separatism



Organized Crime



Assassination



Social Unrest

Natural Catastrophe



NatCat



Earthquake



Windstorm



Volcanic Eruption



Flood



Tsunami

Climatic Catastrophe



WeatherCat



Drought



Freeze



Tornado & Hail



Electric Storm



Heatwave

Environmental Catastrophe



EcoCat



Sea Level Rise



Ocean System Change



Wildfire



Pollution Event



Atmospheric System Change

Technological Catastrophe



TechCat



Nuclear Meltdown



Industrial Accident



Cyber Catastrophe



Technological Accident



Infrastructure Failure

Disease Outbreak



HealthCat



Human Epidemic



Animal Epidemic



Waterborne Epidemic



Zoonosis



Plant Epidemic

Humanitarian Crisis



AidCat



Famine



Water Supply Failure



Child Poverty



Welfare System Failure



Refugee Crisis

Externality



SpaceCat



Meteorite



Solar Storm



Space Threat



Ozone Layer Collapse



Satellite System Failure

Other



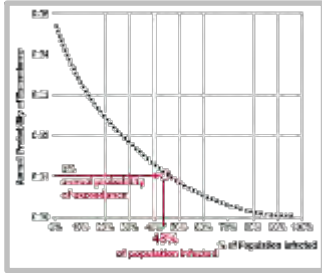
NextCat



Scenario Development Process

Historical Context

A justification and context for a 1% annual probability of occurrence worldwide



Timeline & Footprint

Sequencing of events in time and space in hypothetical scenario



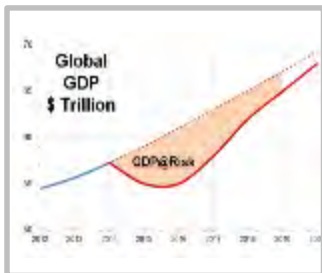
Narrative

Detailed description of events
3-4 variants of key assumptions for sensitivity testing

Loss Assessment

Metrics of underwriting loss across many different lines of insurance business

Specialty	
Accident & health	5
Agriculture Insurance	1
Contingency - film & event	1
Equine Insurance	1
Excess & Surplus	10
Life Insurance	4
Livestock	8
Impact on Insurance Claims	
Decrease	Increase
-5	5
-4	4
-3	3
-2	2
-1	1
0	0
1	1
2	2
3	3
4	4
5	5



Macroeconomic Consequences

Quantification of effects on
Industry sectors and the global economy

Insurance Industry Impact

Total loss estimation of scenario
for the insurance industry



CCRS Research Outputs



Taxonomy of Threats



Geopolitical Conflict
Emerging Risk Scenario



Pandemic
Emerging Risk Scenario



Cyber Catastrophe
Emerging Risk Scenario



Social Unrest
Emerging Risk Scenario



Ebola
Emerging Risk Scenario



Financial Catastrophes



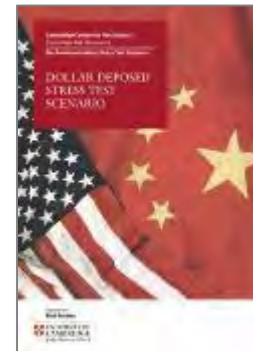
Global Property Crash
Financial Risk Scenario



Eurozone Meltdown
Financial Risk Scenario



High Inflation
Financial Risk Scenario



Dollar Deethroned
Financial Risk Scenario



Historical Crises
Financial Risk



Cyber Accumulation
Insurance Risk Report



NatCat FinCats
Clash Report



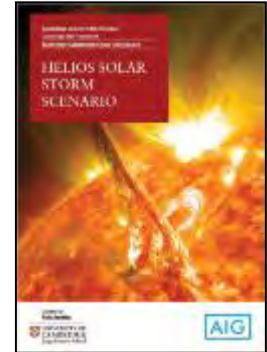
Business Blackout
Lloyds Emerging Risk Report



Climate Change
Investor Sentiment Shock



World City Risk 2025
Lloyds Co-Branded Report



Solar Storm
Emerging Risk Scenario

The Knowledge Economy

Old

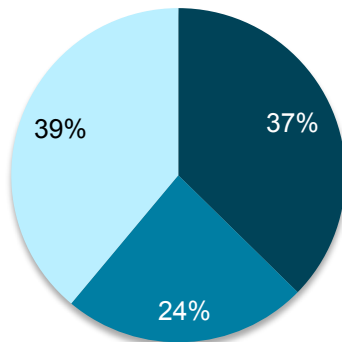


New

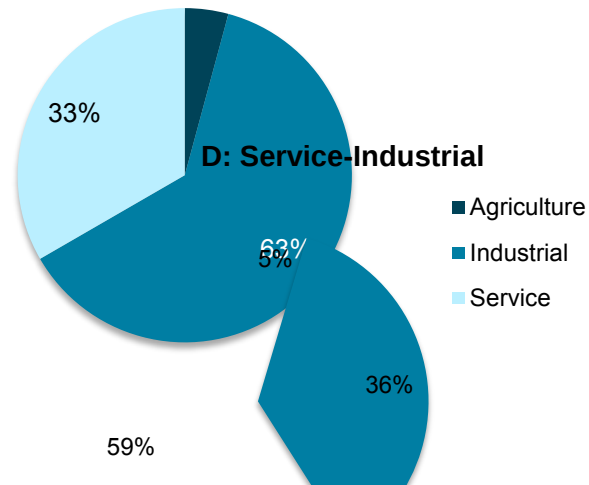


Economies categorised by dependency on critical infrastructure

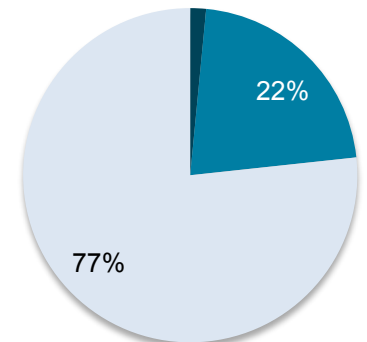
Agriculture with Industry & Service



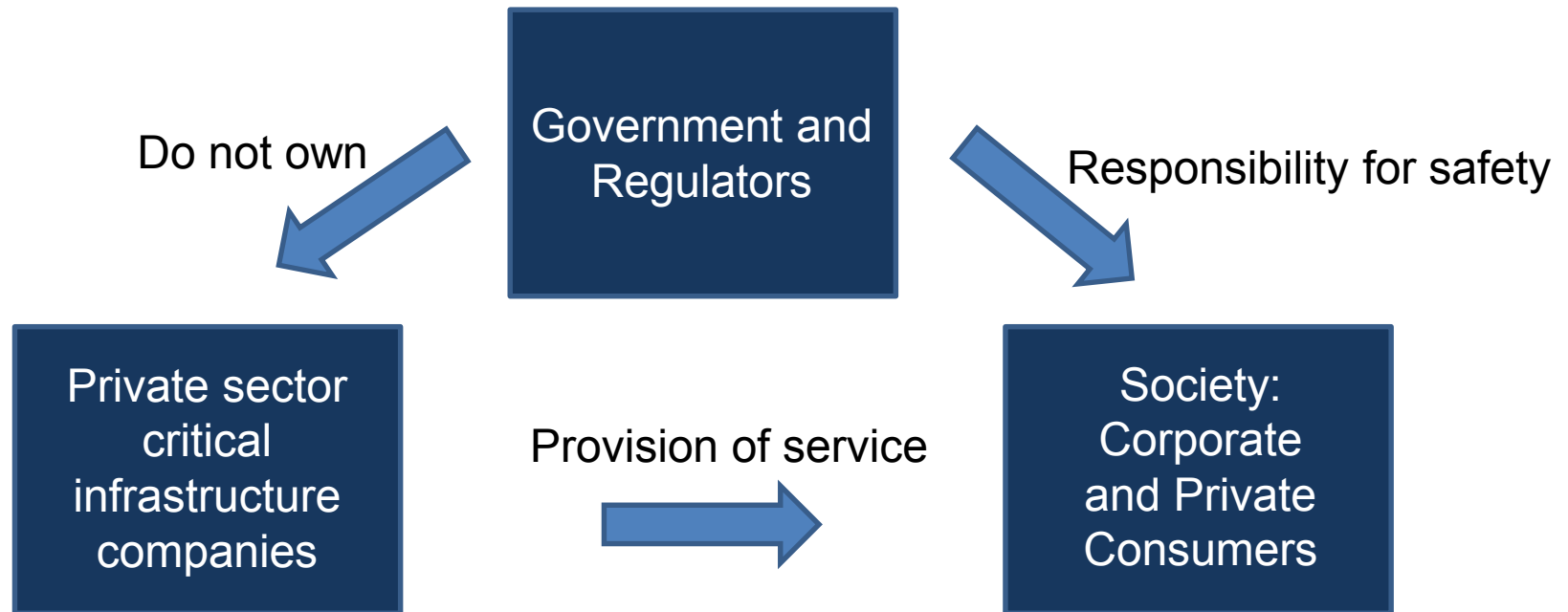
Industrial-Oriented Economy



Service-Dominated Economy



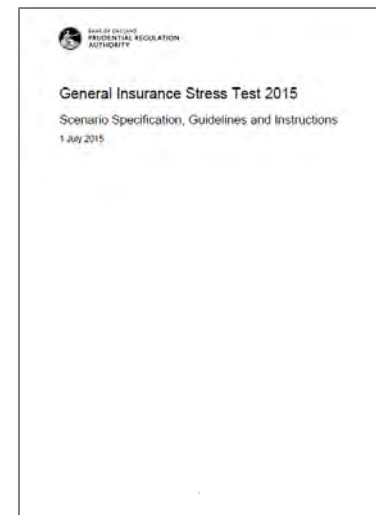
Triangle of Pain



Optimizing the risk equation: who bears the risk?

Context from the Regulators

- Lloyd's Report: Solar Storm Risk to the North American Electric Grid
 - Proposes 1 in 150 year Carrington-level scenario where EHV transformers are destroyed resulting in extended outage.
 - US population at risk 20-40m, 16 day to 1-2 year duration
- PRA General Insurance Stress Test 2015
 - Proposes power transformers knocked out
 - Causing power outages in US and UK
 - At least 1 month to replace transformers



Subject Matter Specialists



*Scenario Development Workshop
held in Cambridge, 29th July 2015*



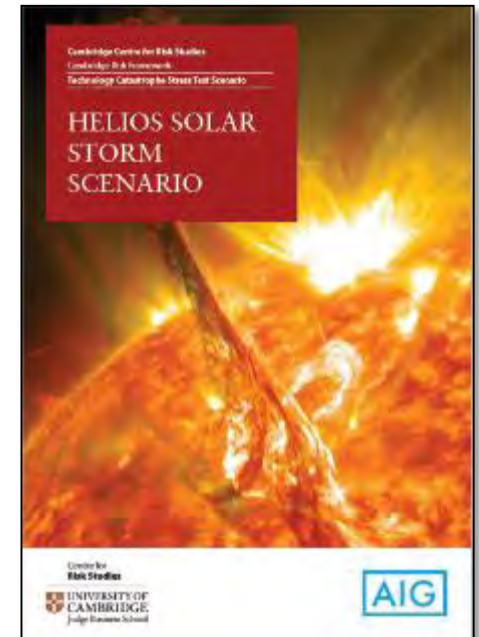
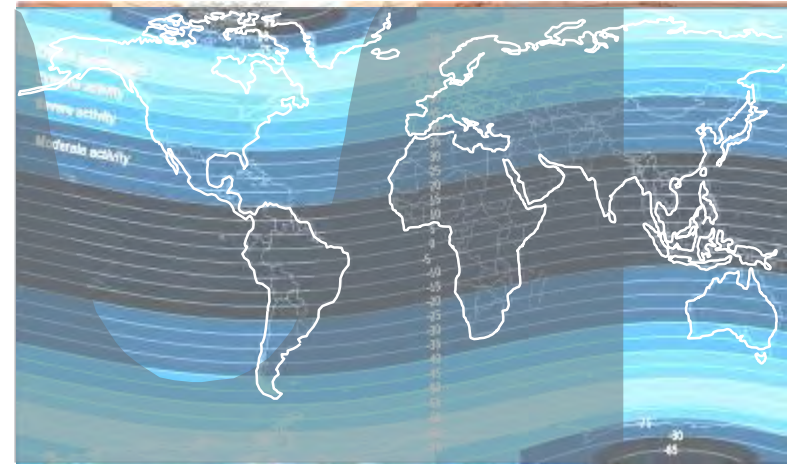
- British Antarctic Survey
- Cambridge Department of Applied Mathematics and Theoretical Physics
- British Geological Survey
- University of Cape Town
- Representatives from North American and UK Electricity Industries

Standard Disclaimer

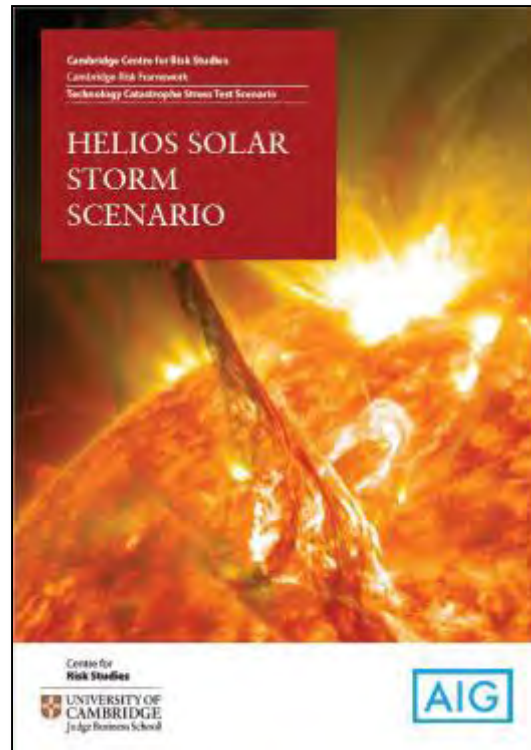
- This scenario is not a prediction
- It is not trying to highlight any specific vulnerability in any power grid system
- This is a stress test scenario for risk management purposes

Helios Solar Storm Hypothetical Catastrophe Event

- 3 scenario variants (S1, S2, X1)
- Solar storm causes charged particles to be deposited directly above North America
- GIC intensifications in US take place down to 20° magnetic latitude
- 6% of EHV transformers in US power grid are damaged
- Damage to 132 EHV transformers (11 severe)
- Damage to satellites
- 28% of US population suffer initial outage
- Produces a power outage across United States, taking 6-12 months to fully restore
- Total shock for US \$ Bn: \$474bn - \$2,693bn
- US Insurance Industry Loss: \$55bn – \$338bn.



Download the Report



■ cambridgeriskframework.com/downloads