NOAA Satellite Anomaly Mitigation Stakeholders Meeting
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ASIC
ATRIUM SPACE INSURANCE CONSORTIUM

FINANCIAL IMPACT OF SPACE WEATHER ANOMALIES – AN INSURER'S PERSPECTIVE

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OUTLINE

- Background on Lloyd's and Atrium Space Insurance Consortium (ASIC)
- The Space Insurance Market
- Space Weather versus Satellite Anomalies and Insurance Claims
- Relevance of Space Weather Forecasting to Insurers
- Summary/Conclusions

INSURANCE AT LLOYD'S

1688 - Edward Lloyd's coffee shop

- Began with shipping, but continued to evolve with each new emerging market – automobiles, aviation, space

Lloyd's will insure (almost) anything:

- Egan Ronay's tastebuds ($400,000)
- Celine Dion's vocal chords
- Michael Flatley's legs ($47 million)

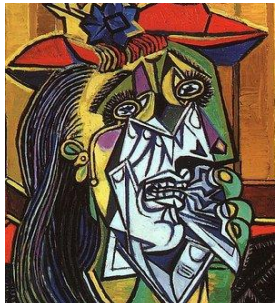
- In 2010 Lloyd's comprised:
  - 84 syndicates
  - 773 names (unlimited liability)
  - 1238 corporate members (limited liability)
- £22 billion of gross premium was written in 2010

CLASSES OF INSURANCE

Motor

Energy

Bloodstock

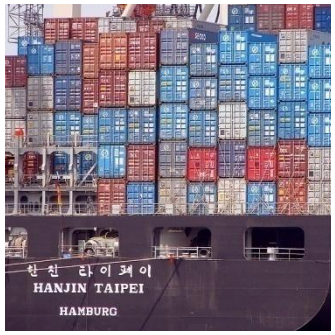


Fine Art

Aviation

Property

Kidnap & Ransom



Cargo

Specie

Marine

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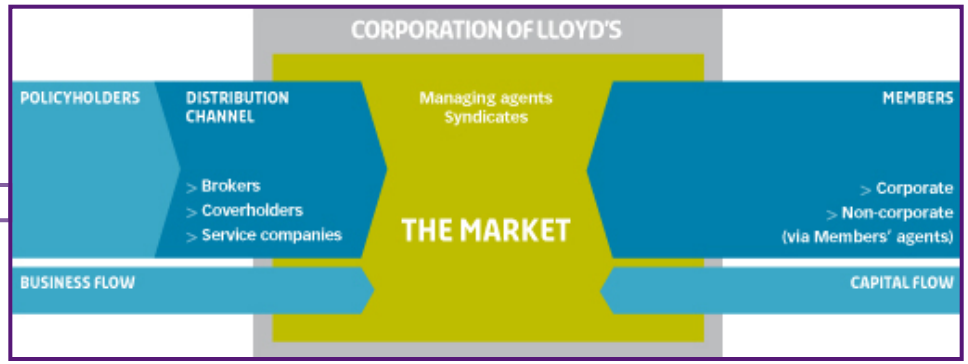


ASIC
ATRIUM SPACE INSURANCE CONSORTIUM

Atrium is a specialist insurer and reinsurer at Lloyd's. Its underwriting capacity for 2012 is £420M (approximately $650M)

ASIC comprises 8 Lloyd's syndicates

$30M line on any one launch / satellite

SPACE INSURANCE SCOPE

Pre-Launch

Launch

In-Orbit

Third Party Liability

THE SPACE INSURANCE MARKET

- **Customer base:** 50 or so satellite operators, primarily GEO communication satellite operators and a small number of LEO operators
- **Insured launches per year:** Between 30-35 insured launches take place every year. Coverage typically begins at “intentional ignition” and expires 1 year from launch
- **Insured in-orbit satellites per year:** Approximately 190 satellites are insured each year, typically on an annual basis, representing approximately half of all commercial satellites,
- **Total insured value in orbit:** ~$22 billion; $20.6 billion in GEO, $1.4 billion in LEO
- **Basis of coverage:** Replacement value (Total Loss), or lost capacity (Partial Loss)
- **Scope of coverage:** Insured against any and all causes of failure except terrorism , civil unrest, and war, including the use of anti-satellite weapons

RISK ASSESSMENT

- We know space weather causes satellite anomalies
- Space insurance covers “all risks”
- As Insurers, what we have to assess is:
  1) What is the likelihood of a claim arising from a space weather event?
  2) How much is the claim likely to be?

SATELLITE ANOMALIES

WHAT HAS BEEN OUR EXPERIENCE TO DATE?

SATELLITE ANOMALIES

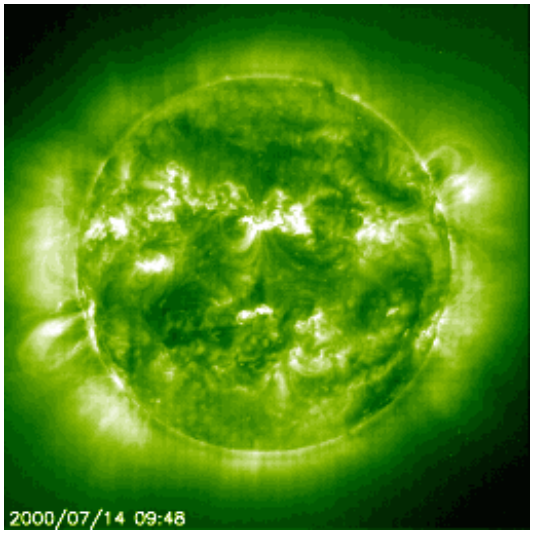
Subsystem	All Anomalies	%	Space Environment only	%	TLs or PLs	%
Communications Payloads	572	25%	124	29%		
Optical / Imaging Payloads	11	0.5%	1	0.2%		
ACS incl. computer	567	25%	118	27%		
Power	432	19%	85	20%	8	89%
T & C / Data handling	257	11%	95	22%	1	11%
Prop	275	12%	4	1%		
Thermal	131	6%	8	2%		
Mechanisms	17	1%				
Structure	1	0.04%				
Unattributed	11	0.5%				
Launch Failure	28	1%				
Totals	2302	100%	435	100%	9	100%
			19%		0.4%	

The ASIC database includes anomalies from 922 satellites going back to 1986

SATELLITE ANOMALIES

- **Only a relatively small proportion of satellite anomalies to date were attributable to space weather.**
- **How many of these anomalies resulted in claims?**

REAL-LIFE WORST-CASE SCENARIOS

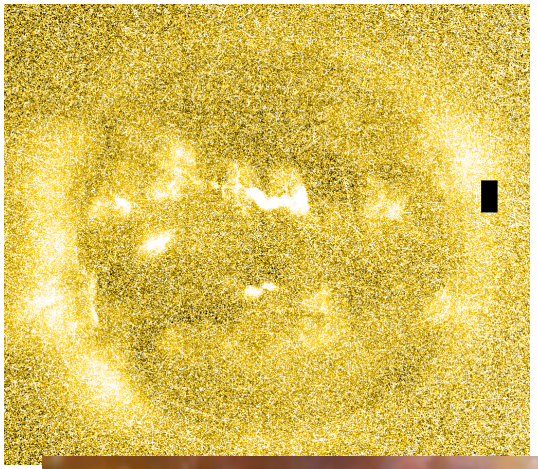


Ref: ESA

BASTILLE DAY STORM (July 2000)

- Coronal Mass Ejection (CME) unleashed billions of tons of plasma travelling at 4 million miles per hour (double usual speed)
- Nine hour G5 geomagnetic storm
- Aurora seen in El Paso, Texas (31ºN)
- GPS accuracy degraded leading to re-routing of aircraft
- GOES 8, GOES 10, ACE, WIND, SOHO instruments temporarily blinded
- Astro-D satellite permanently lost
- Degradation of solar arrays on numerous GEO satellites
- Degradation of pointing on numerous GEO satellites

INSURANCE CLAIMS = $0



Ref: ESA

HALLOWEEN STORM (October 2003)

- GPS accuracy degraded leading to re-routing of aircraft
- Power outage in Sweden
- More than half of deep space and near Earth missions experienced effects
- 45 satellites reported anomalies
- Voyager 2 experienced diffuse particle stream in April 2004 at a distance of 7 billion miles

ACTUAL CLAIMS

- During the years 1994 – 2011 the total amount of claims was $10,793M. Only two claims were unambiguously attributable to space weather:
  - Anik E1 - $142.5M
  - Telstar 401 - $132.0M

  $274.5M, less than 3% of the overall total
- *However, this does not imply that space weather can be ignored as a risk.*

QUESTION NUMBER 1:

- **We know that space weather causes satellite anomalies**
- **We know that satellite anomalies can result in claims**
- **We don't want to get claims.**
- **The more that can be done to prevent claims the happier we will be.**

So - is the risk from space weather being adequately controlled?

RISK - SOME OPEN QUESTIONS

- **Why is such a variation seen in anomalies between same-type satellites?**
- **Do designers have a full understanding of the interaction between the space environment and each design and manufacturing variable?**
- **What is the true worst-case boundary condition for design?**
- **Should top-level ESD-type immunity testing be included as part of a comprehensive test program?**

SPACE WEATHER FORECASTING – IS IT USEFUL TO INSURERS?

SPACE WEATHER FORECASTING

- The decision … essment of the overall risk, in…
- Space weathe… bject of a blanket exclusion; risk… ust be factored into the overa…
- However, on … shown abnormal sensitivity to s… s and exclusions can be applie… gned, we are bound.

SUMMARY & CONCLUSIONS

- Insurers know that space weather is a definite contributor to risk.
- However, this risk is usually small in relation to other risk factors.
- The risk posed by space weather is being controlled to a reasonable degree, although we feel there is room for some improvement.
- Space weather forecasting in its present state of development is of limited value to insurers.
  - That said, it can lead to improvements in the design of satellites which will benefit us all.