












TERRORISM MODELING

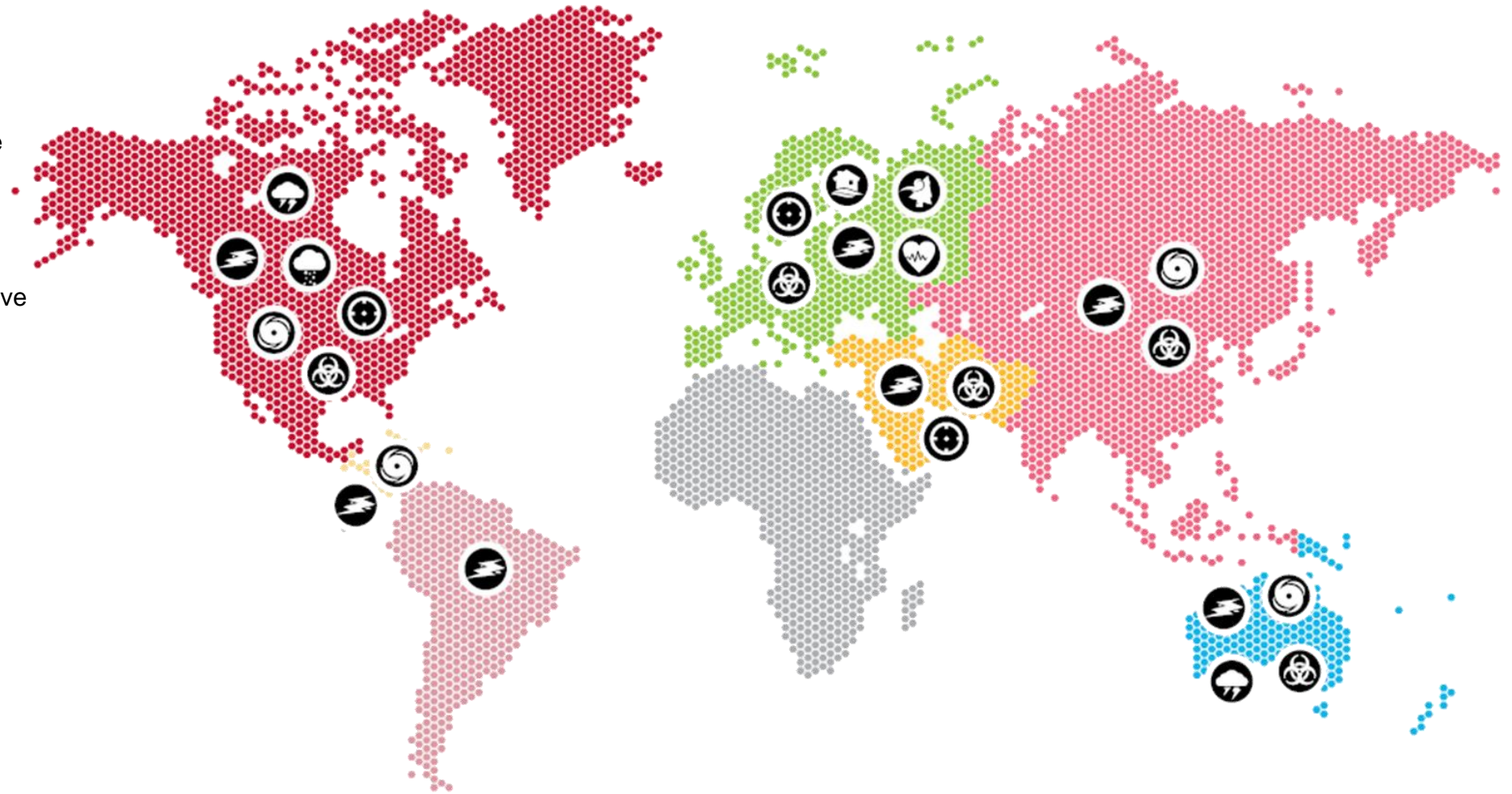
Chris Folkman, Senior Director, Product

AGENDA

- What is a catastrophe model and why use one?
- Terrorism modeling, and how it differs from natural catastrophe modeling
- The terrorism threat environment and its modeling implications
- Q&A and Discussion

RMS MODELS

-  Earthquake
-  Tropical Cyclone
-  Windstorm
-  Severe Convective Storm
-  Winter Storm
-  Flood
-  Terrorism
-  Pandemic
-  Longevity



9/11 insured loss

\$44 billion

WTC site footprint

16 acres

First Terrorism Model

2002



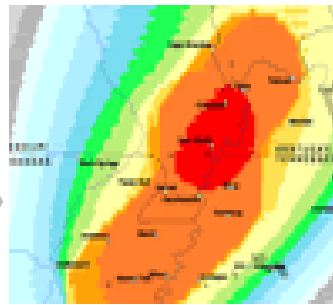
CALCULATION STEPS OF A CAT MODEL



Apply Exposure

Addresses → lat long

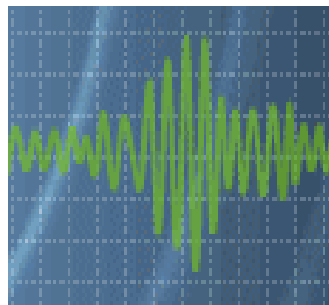
Value of Building, Contents, Business Interruption.



Generate Events

Which events in the catalog affect exposure at risk?

65,000 events in U.S. Terrorism Model



Assess Hazard

Bomb blast intensity

Wind Speed

Flood Depth

Ground shaking Intensity



Calculate Damage

Damage to each location

Uncertainty measure of damage (corre



Quantify Financial Loss

Exceedance probability (1-in-100, 1-in-250)

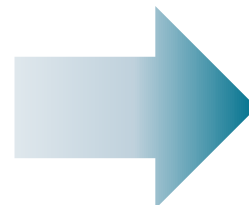
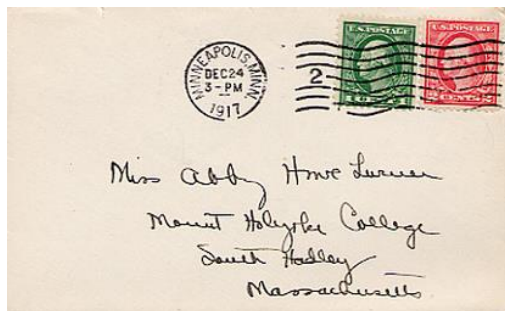
Average Annual Loss (Pure Premium)

Apply Limits, Deductibles, Treaty Terms

EXPOSURE MODELING: GEOCODING

- **Translation of address data**

- From “local coordinates”
 - like mailing addresses

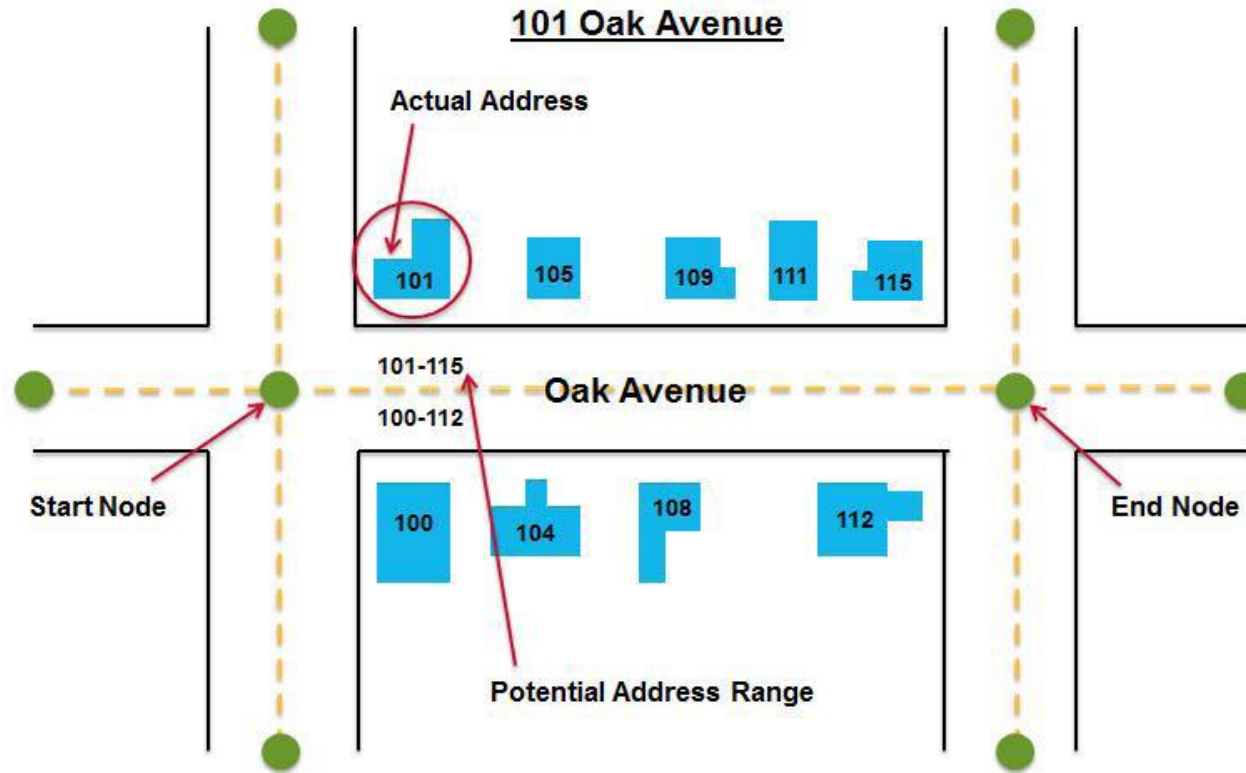


- Into “global coordinates”
 - latitude, longitude (37.7561° N, 122.2744° W)

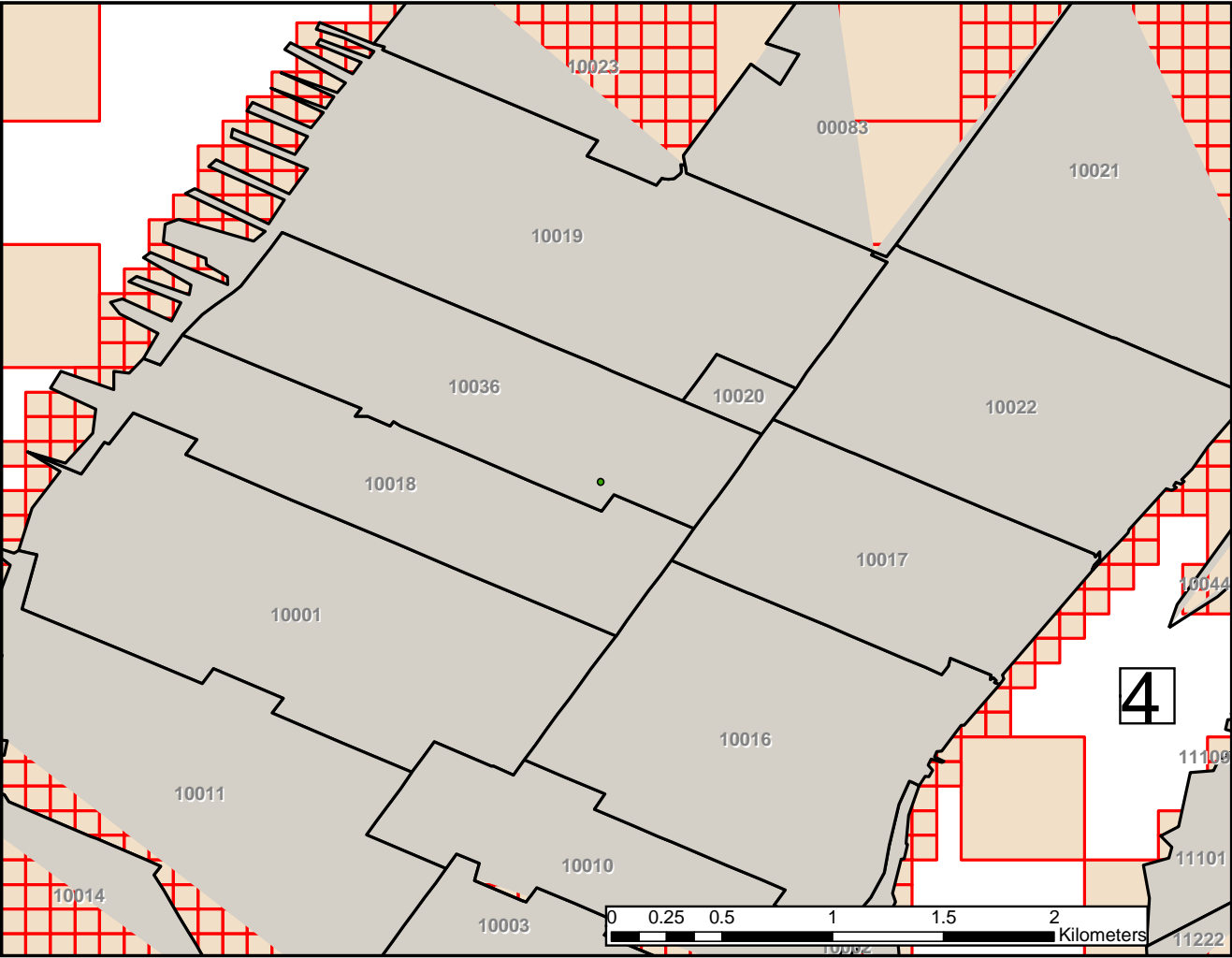
- **Preparation of data for analysis**

- Retrieval of “Grid Cell ID” for model

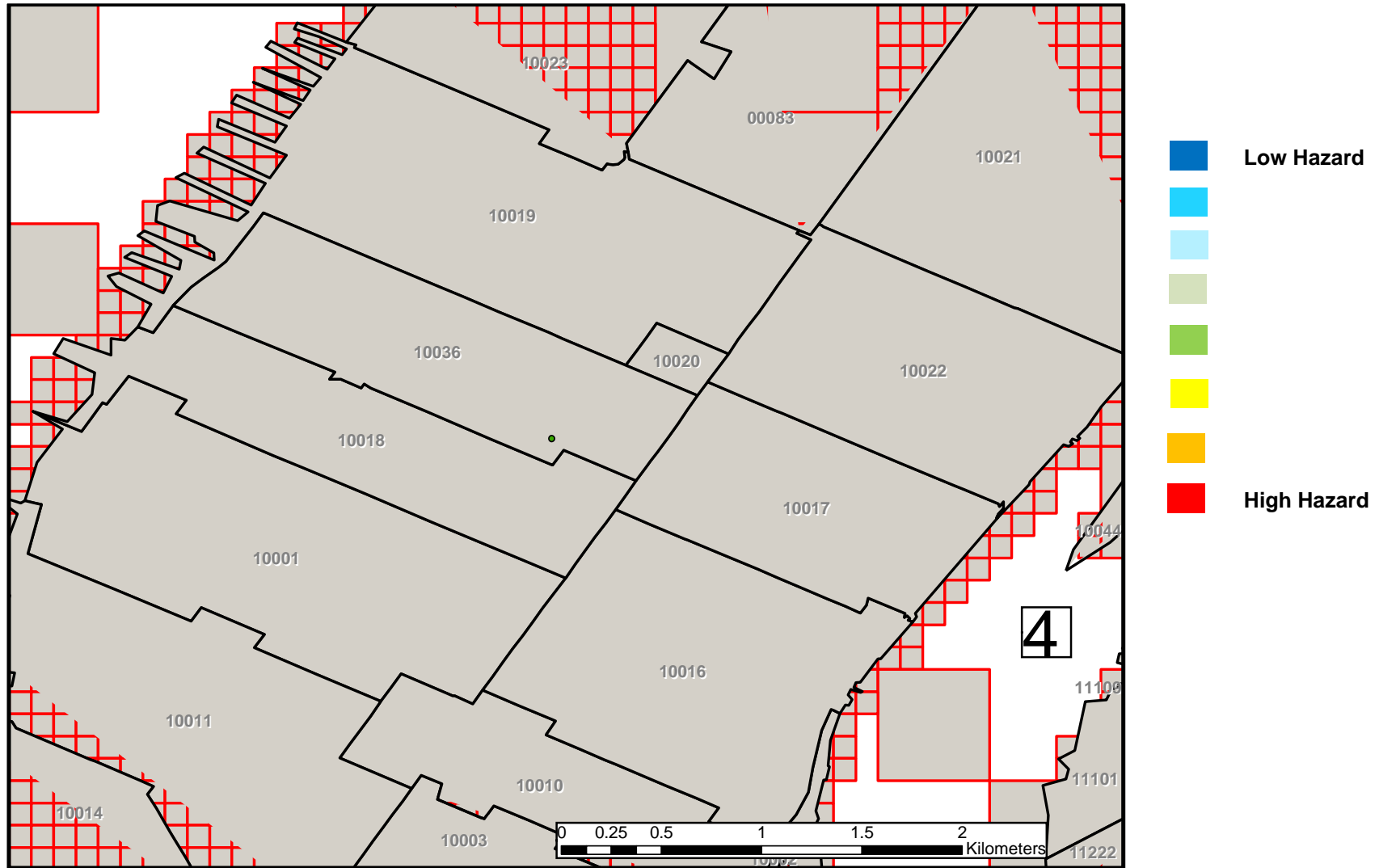
GEOCODING: U.S. EXAMPLE



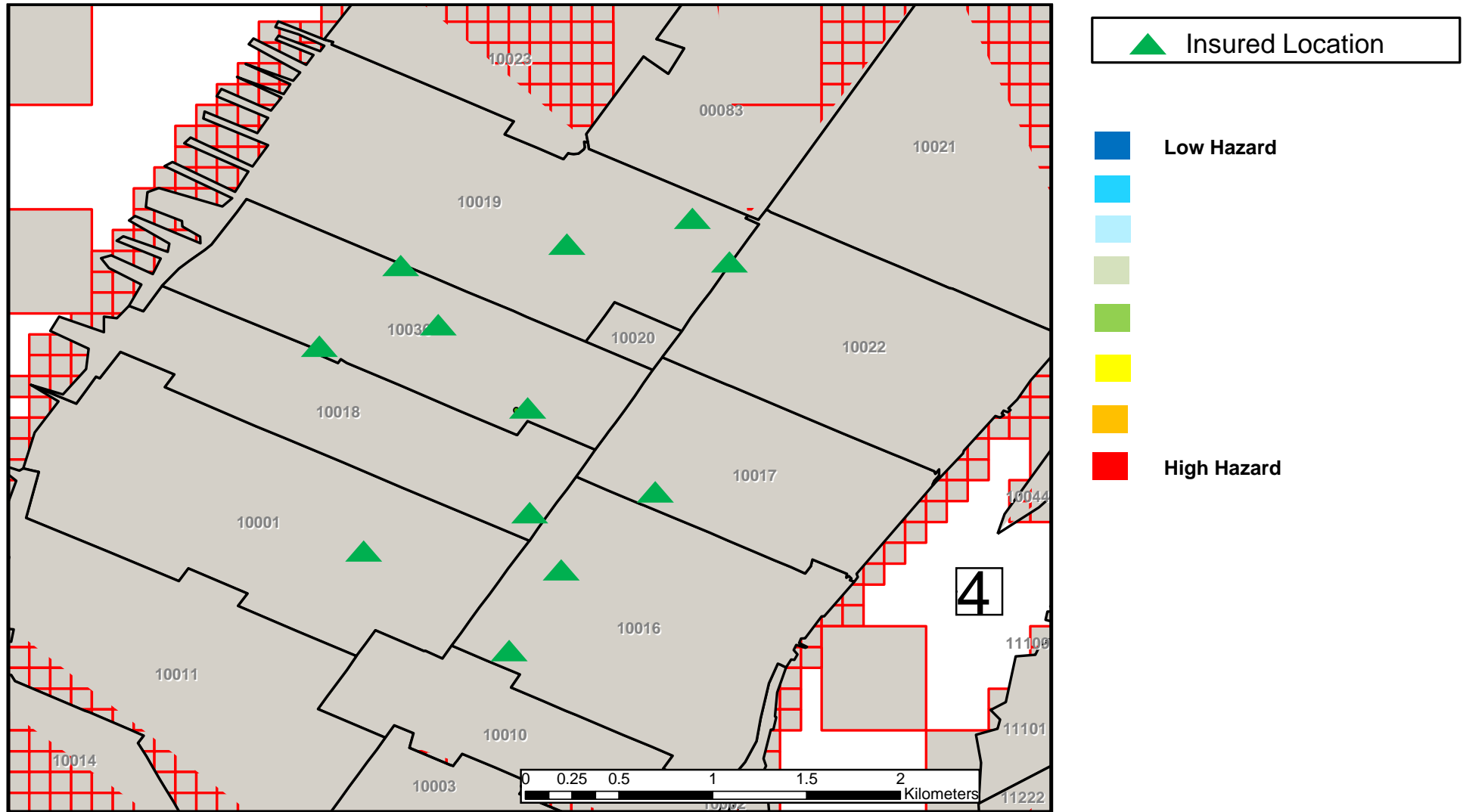
EXPOSURE MODELING: GLOBAL GRID SYSTEM



HAZARD OVERLAY

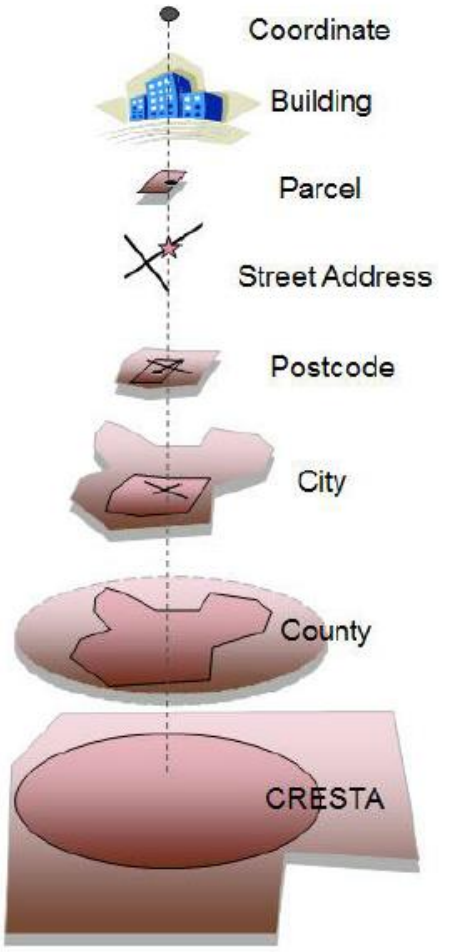


ASSIGN LOCATIONS TO GRID CELLS



... TO DETERMINE HAZARD VALUE FOR EACH LOCATION

THE IMPORTANCE OF GOOD ADDRESS DATA



- All addresses in a portfolio are translated to a single point.
- GOOD geocoding (in the U.S): building-level or street level.
- BAD geocoding: post-code, county, state.
- Perils like flood and terrorism → VERY sensitive to address resolution.
- Inaccurate exposure data will lead to the wrong answer:
 - Unnecessary conservatism in underwriting and portfolio management.
 - False confidence in risk avoidance
 - Inefficient use of capital

HAZARD GRADIENT

gra·di·ent. /grādēənt/

an increase or decrease in the magnitude of a property (e.g., temperature, pressure, or concentration) observed in passing from one point or moment to another.

Which of the following have high hazard gradients?

- **Hurricane**
- **Earthquake**
- **Tornado**
- **Bomb Blast**
- **Flood**



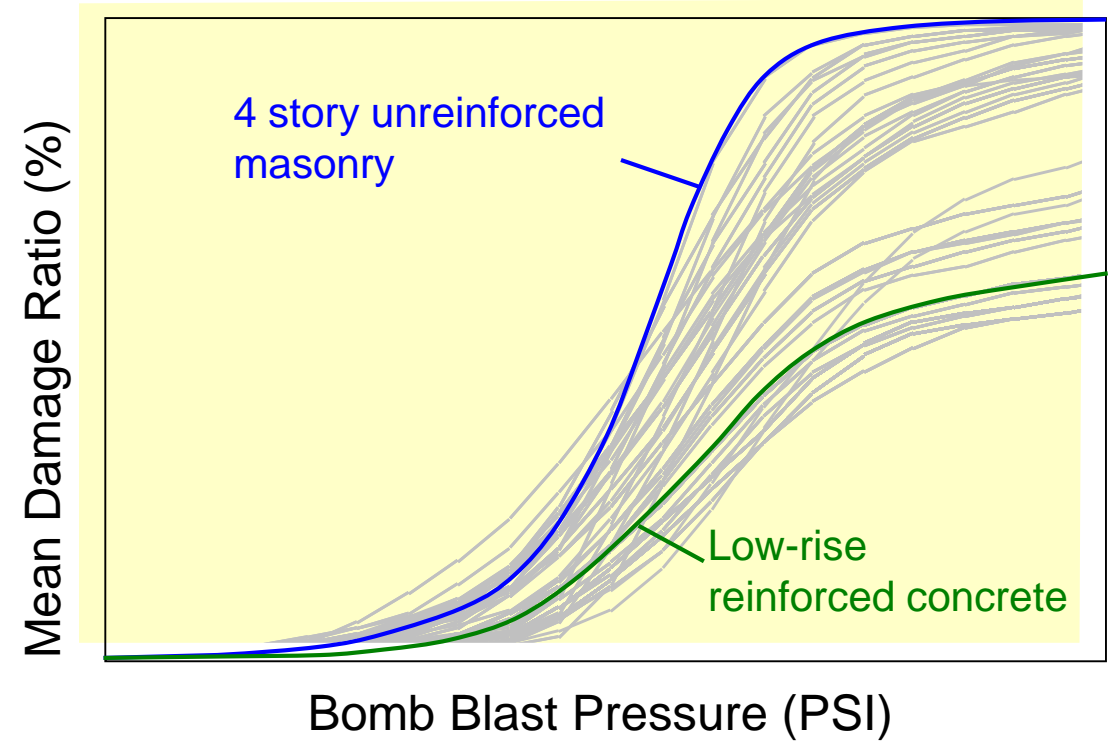
VULNERABILITY

(Given that a building is subject to a certain blast pressure, what will be its damage?)

Vulnerability functions are defined by key building features

- **Construction class**
- **Building height**
- Year of construction
- Occupancy type

Example Vulnerability Module

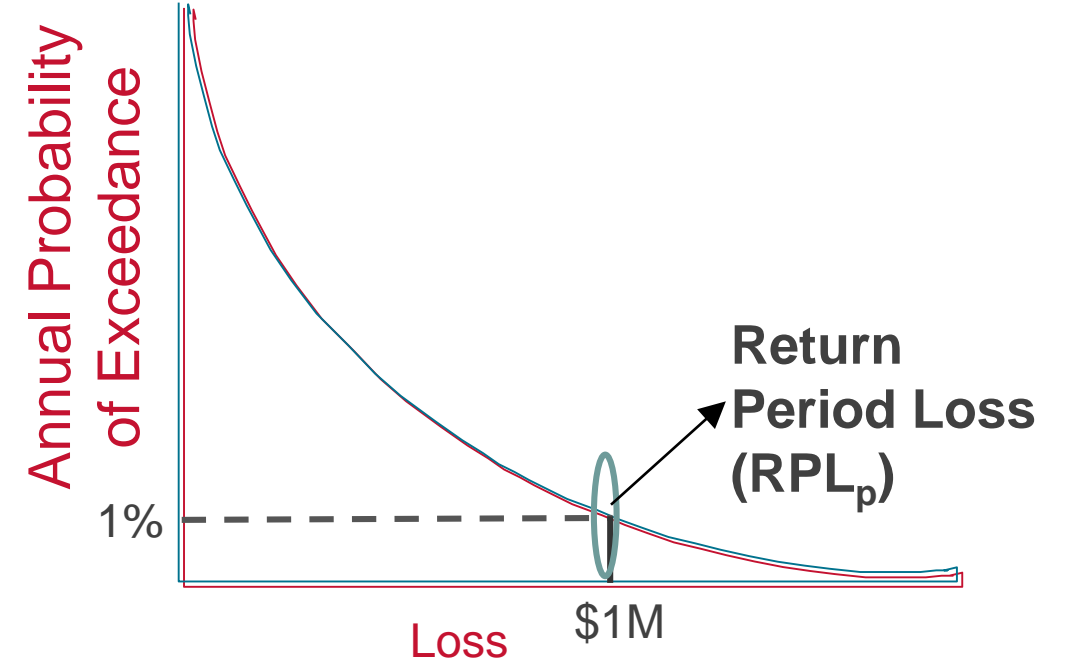


FINANCIAL MODEL OUTPUT: THE BASICS

Event Loss Table (ELT)

Event	Loss (I)	Annual Rate (r)	Return Period	Rate * Loss
1	\$5 M	0.04	25	0.2
2	\$3 M	0.08	13	0.24
3	\$25 M	0.005	200	0.125
4	\$12 MM	0.008	125	0.096
5	\$50 MM	0.001	1000	0.05
...
n
All Events				Sum(r*I)

Average Annual Loss (AAL)

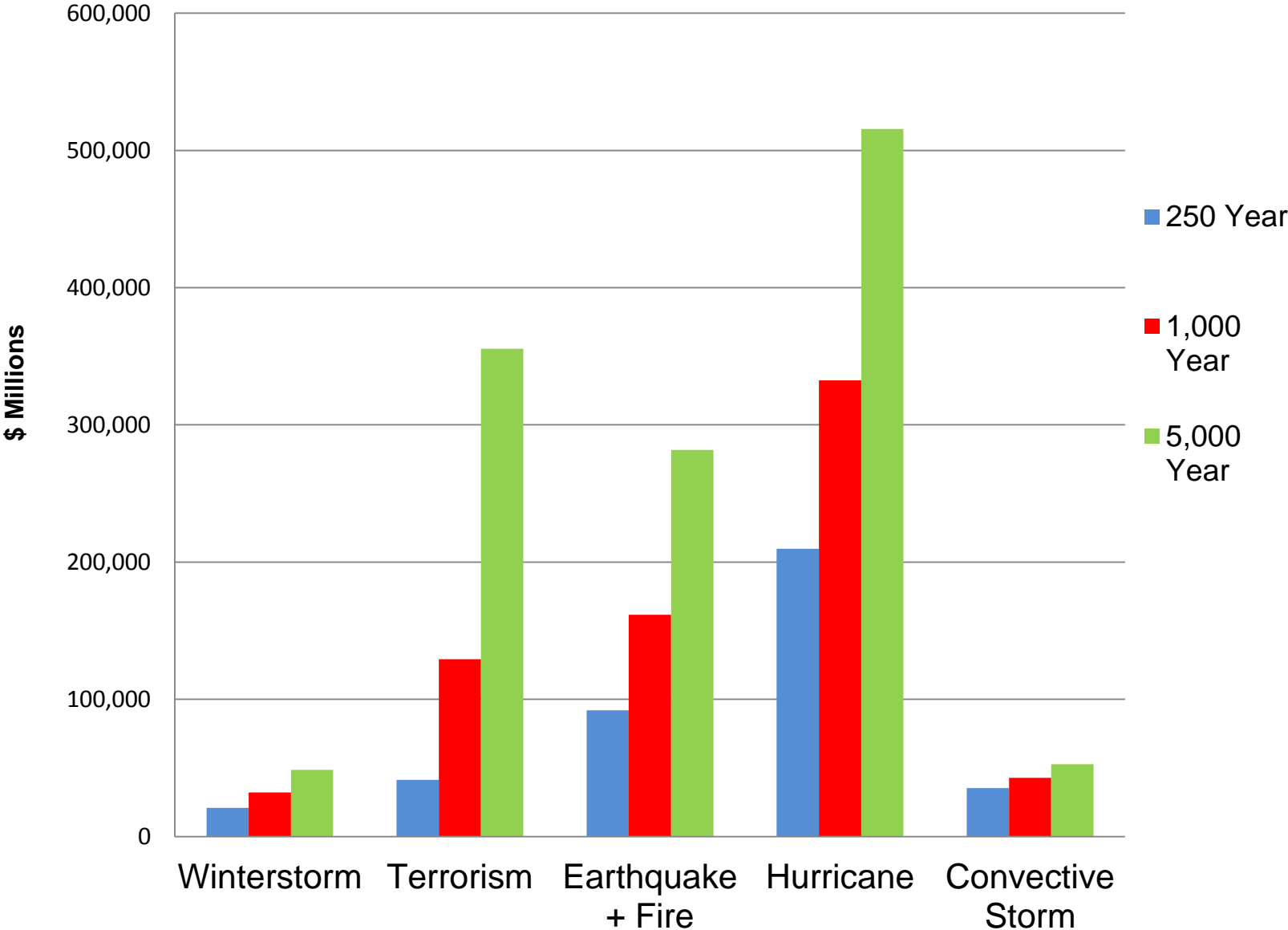


EP (Exceedance Probability) curve

Tail risk analysis; solvency considerations; reinsurance decisions

U.S. Industry Risk By Peril

Uncertainty plays a key role in shaping the exceedance probability curve, showing losses at key return periods.



CAT MODELING IS A BIG DATA EXERCISE

Model	# of Simulated Events
Japan Earthquake	30,000
Australia Convective Storm	32,000
Europe Windstorm	40,000
North Atlantic Hurricane	50,000
U.S. Terrorism	65,000
North America Severe Convective Storm	83,000
China Earthquake	85,000

Example: for a portfolio of 350,000 locations in a terrorism analysis:

- 350,000 locations x 35,000 events x 5 financial terms (limits, deductibles, exclusions, etc.) x 5 geocoding calculations x 2 hazard retrievals x 4 vulnerability calculations =

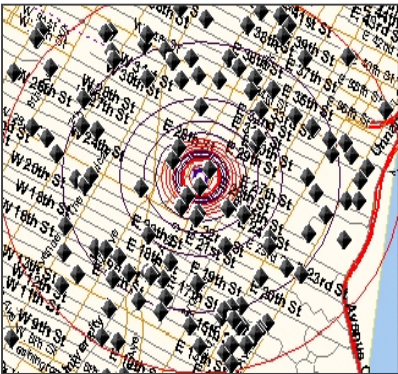
2.5 trillion calculations. And a lot of data produced.

TERRORISM RISK MANAGEMENT

A “THREE PRONGED APPROACH”

EXPOSURE MANAGEMENT

- Monitor exposure concentration around high risk targets.
- Identify building level accumulations.
- Identify exposure “Hot Spots” within given radius.



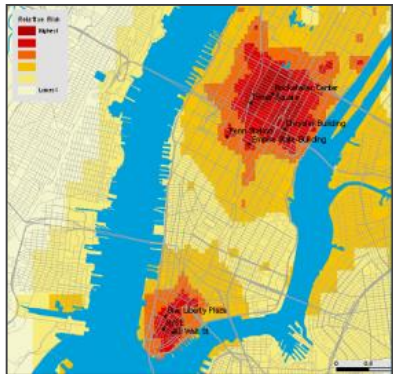
SCENARIO LOSS MODELING

- Quantify loss for on attack scenario.
- Manage losses of benchmark scenarios to acceptable levels.
- Submitted to rating agencies (i.e. AM Best).

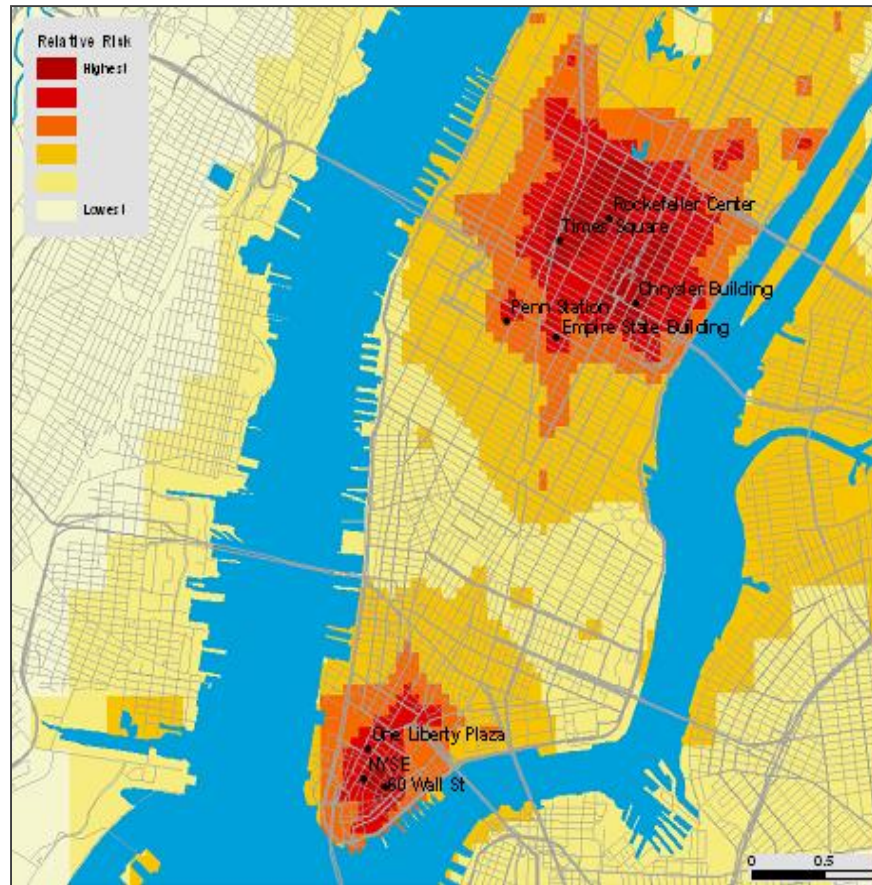


PROBABILISTIC LOSS MODELING

- Identify most critical attack scenarios for a portfolio
- Rank portfolios or accounts by their risk of terrorism.
- Calculate impact of multiple attacks as part of a single event (multiplicity).



PROBABILISTIC MODELING OF TERRORISM



- 65,000 U.S. attack simulations
- Relative risk by city, target type, weapon selection
- Output enables drill down: by account, location, target type, city, line of business
- Assist underwriters in risk selection
- Design and implement underwriting guidelines
- Capacity allocation
- Evaluate reinsurance needs and options

COMPONENTS OF TERRORISM LIKELIHOOD

SAMPLE TERRORISM PROBABILITY DISTRIBUTION

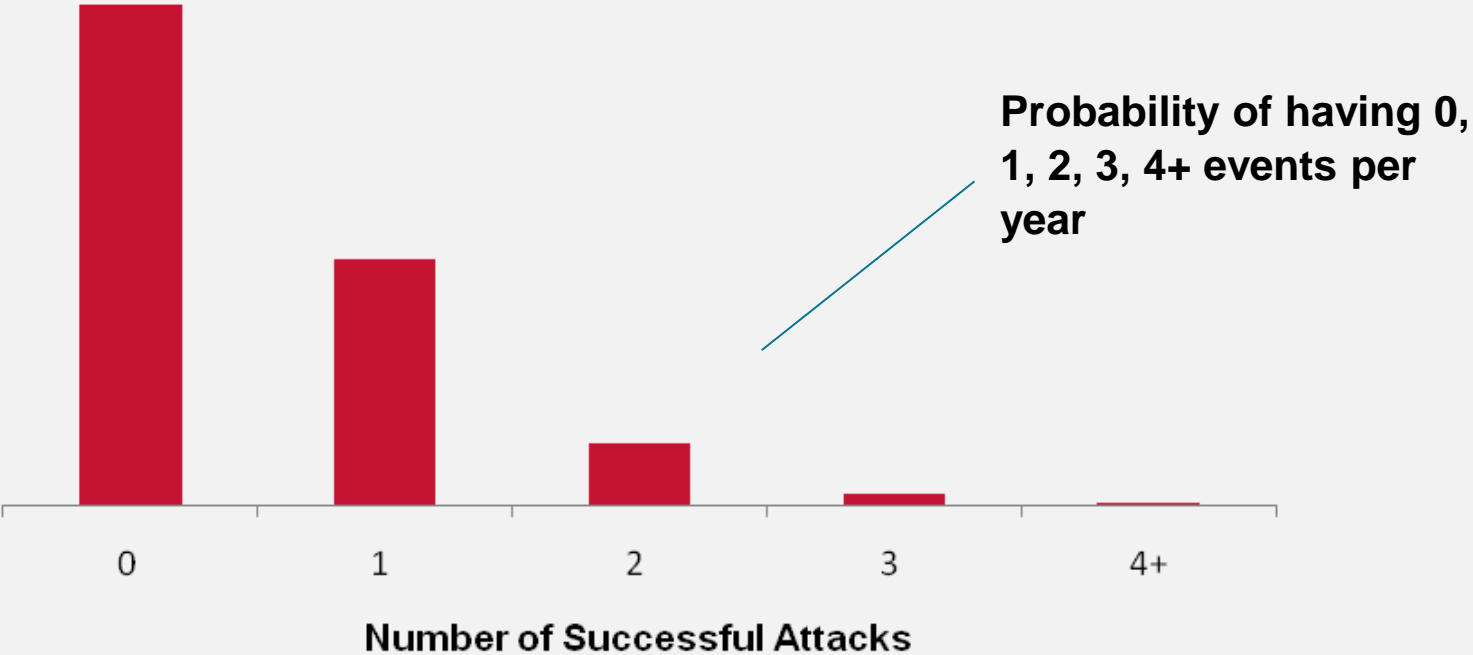
Components of Terrorism Likelihood:

- Frequency

- Multiplicity
- Conditional Probability

Data behind this:

- # of intercepted plots
- # of successful attacks
- Countersecurity effectiveness and funding
- All inputs to a Monte Carlo simulation that informs distribution



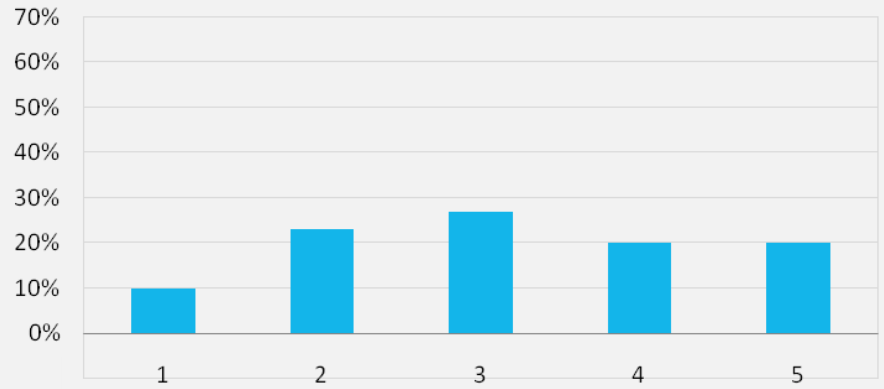
MULTIPLICITY IS A HALLMARK OF TERRORIST ATTACKS

Probability of having up to n synchronous, coordinated attacks

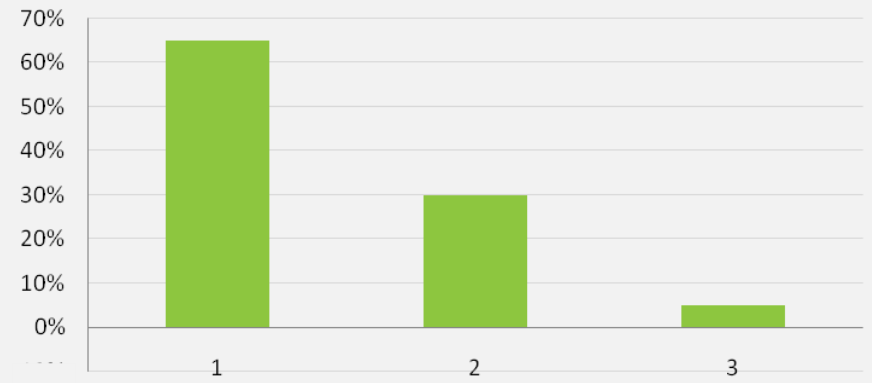
Components of Terrorism Likelihood:

- Frequency
- **Multiplicity**
- Conditional Probability

600 lb. Bomb
Average Multiplicity = **3.17**



Large Dirty Bomb
Average Multiplicity = **1.4**



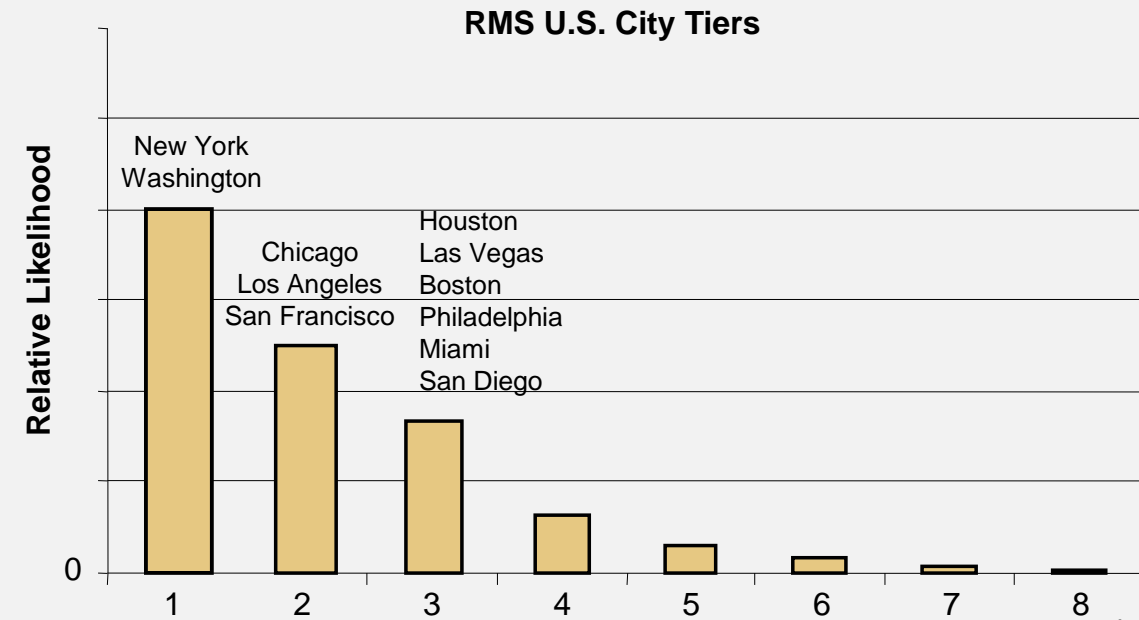
Components of Terrorism Likelihood:

- Frequency
- Multiplicity
- Conditional Probability

Given an attack occurs, what is its the likelihood:

- By City
- By Target
- By Weapon

Category Tier	U.S. Target Categories
Tier 1	Major federal, state, or local government buildings
Tier 2	Airports, central business districts, hotels, casinos, nuclear power plants, skyscrapers, stock exchange buildings
Tier 3	Military bases, road bridges, road tunnels, stadiums, subway stations, train stations, railways used for transportation of Hazmat material
Tier 4	Amusement parks, industrial facilities, natural gas facilities, oil refineries, ports, tourist attractions, shopping malls
Tier 5	Gas stations, HQ of Fortune 100 companies, HQ of media companies, theater/entertainment centers
Tier 6	Foreign consulates, United Nations buildings
Tier 7	All other targets





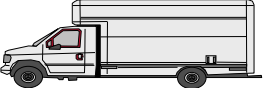


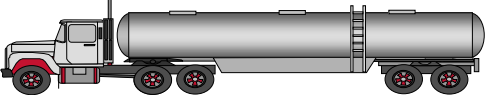
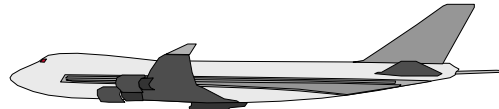
TERRORISM IS DIFFICULT TO INSURE

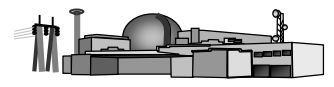
- Loss outcome uncertainty is high.
- Event footprints are small.
- Risk landscape is unpredictable.
- Areas of high risk are areas of high exposure.

Events from RMS industry loss curve

Event Description	Loss (\$Billions)	Fatalities
Nuclear Detonation , 5 kiloton yield, Chicago	\$530	300,000
Anthrax attack , 75 kg anthrax slurry, Philadelphia	\$216	60,000
Nuclear Power Plant Sabotage , Illinois	\$148	Few
Dirty Bomb , 15,000 curies cesium-137, New York	\$127	Few
Anthrax attack , 1 kg anthrax slurry, Philadelphia	\$44	10,000
Bomb , 10 ton TNT equivalence, New York	\$40	9,000
Sarin Gas Attack , 1,000 kg release, New York	\$17	2,000

...BUT IT CAN, AND SHOULD BE MODELED

-  600 lb. Car Bomb
-  1 ton Minivan Bomb
-  2 ton Box Van Bomb
-  5 ton Truck Bomb
-  10 ton Trailer Bomb
-  Tanker Conflagration Attack
-  Aircraft Impact Attack



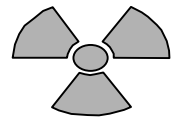
Sabotage Attacks



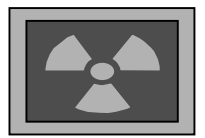
Chemical Agent Attack



Biological Agent Attack



Radiological Attack



Nuclear Detonation

Large scale events (events that can threaten insurer solvency) are easier to understand and model.

Much better data today to model terrorism

- 140,000+ historical attacks worldwide are cataloged
- Hundreds of known large-scale plots
- Dozens of threat groups
- An increasing amount of transparency into counterterrorism specifics:
 - Measures
 - Funding
 - Capability
- Better data → Better Models, more potential for insurance product innovation.

The background image shows a large industrial facility, possibly a power plant or refinery. It features several large, curved, metallic structures with a textured, reflective surface. In the foreground, there are concrete bases for equipment, numbered 4, 5, 6, and 7. The sky is blue with some clouds.

INSURING AGAINST INFRASTRUCTURE FAILURE

TOP SECRET//SI//ORCON//NOFORN



Gmail facebook

msn Hotmail®

YAHOO!

Google™



skype

paltalk.com

YouTube

AOL mail

(TS//SI//NF) PRISM Collection Details



Current Providers

- Microsoft (Hotmail, etc.)
- Google
- Yahoo!
- Facebook
- PalTalk
- YouTube
- Skype
- AOL
- Apple

What Will You Receive in Collection
(Surveillance and Stored Comms)?

It varies by provider. In general:

- E-mail
- Chat – video, voice
- Videos
- Photos
- Stored data
- VoIP
- File transfers
- Video Conferencing
- Notifications of target activity – logins, etc.
- Online Social Networking details
- **Special Requests**

Complete list and details on PRISM web page:

Go PRISMFAA

TOP SECRET//SI//ORCON//NOFORN

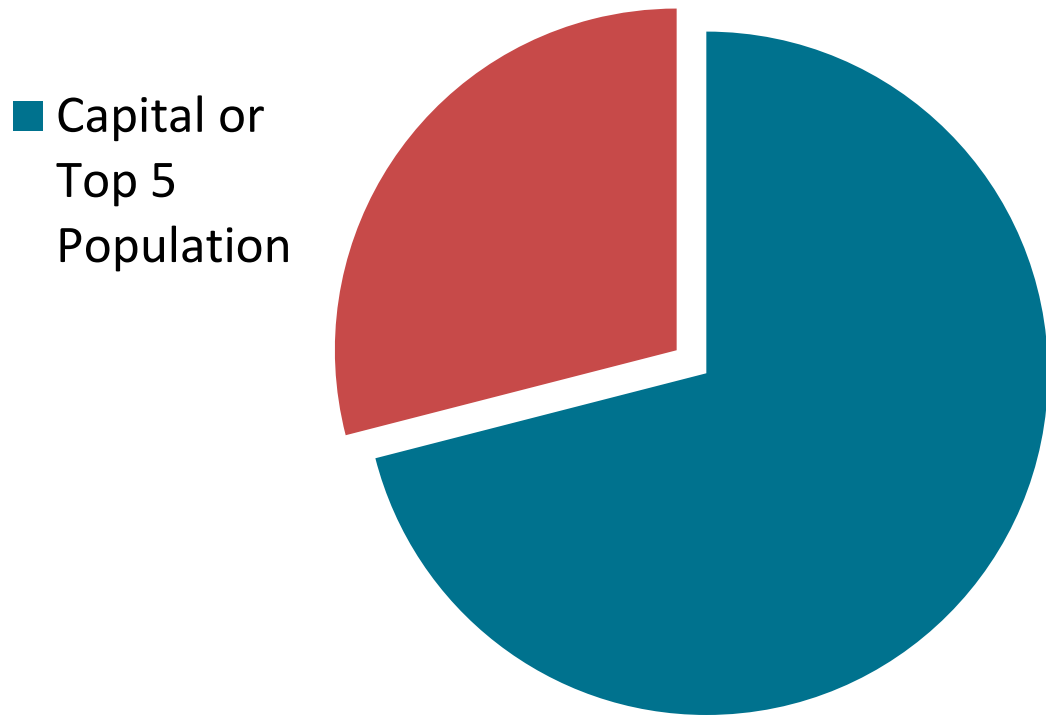


Leaked NSA slide:
how to submit a
surveillance request.

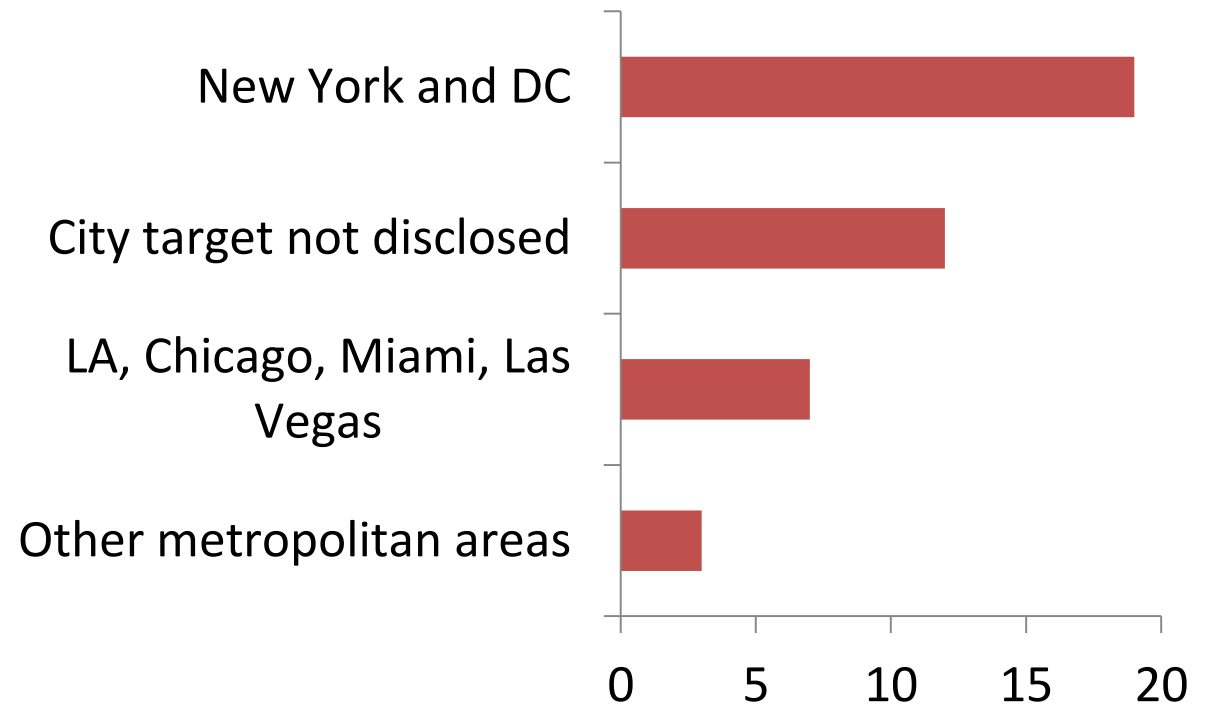
FISA oversight court
surveillance request
approval rate:
99.97%

RISK IS HIGHEST WHERE EXPOSURE IS HIGHEST (MAJOR CITIES)

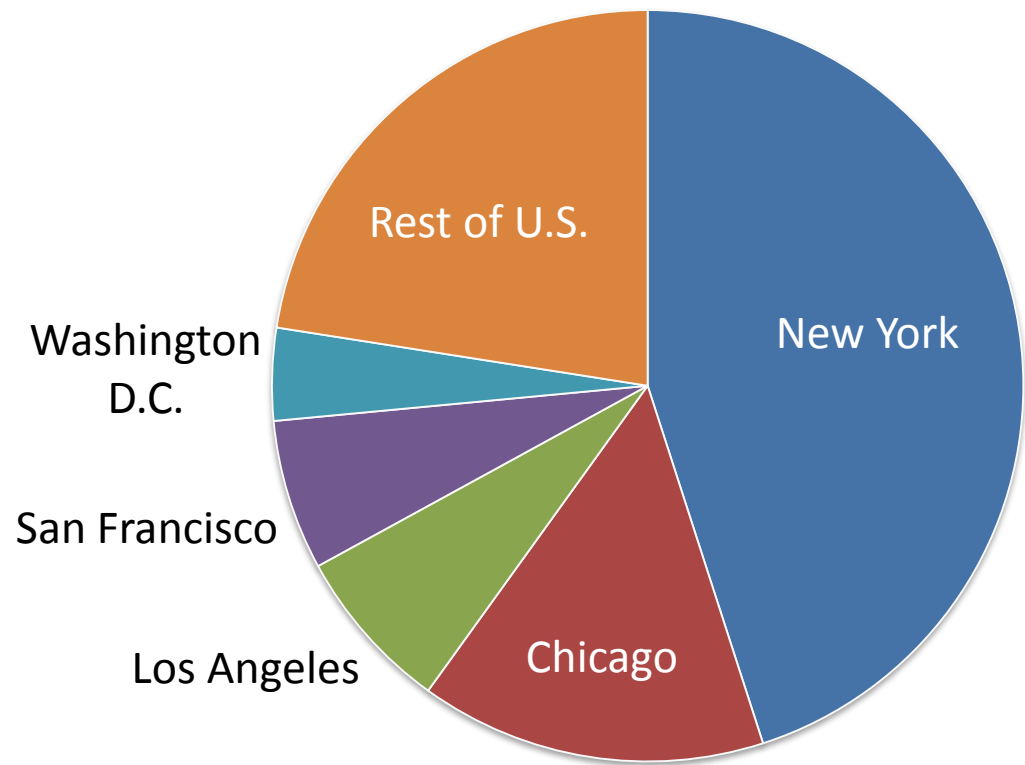
Large Scale Attacks Worldwide



41 terrorist plots intercepted in the U.S., 2002-2015



HIGH RISK + HIGH EXPOSURE = DIVERSIFICATION CONUNDRUM



77%
of expected U.S. loss is concentrated in five metropolitan areas.

AAL from 2016 RMS industry loss curve

TERRORISM INSURANCE TODAY: BETTER MODELS, MORE UNDERWRITING CAPACITY

- 40+ writers of stand-alone terrorism worldwide offering \$3-4 billion capacity.
- Backstopped by government pools (TRIA, Pool Re, GAREAT).
- CBRN increasingly offered as renewal incentive on property policies.
- More commoditization via broker facilities (“take it or leave it”).

TAKEAWAYS

- **Full understanding of terrorism** requires multiple modeling angles:
 - Exposure management
 - Deterministic scenarios
 - Probabilistic modeling
- All terrorism writers make assumptions on event frequency.
 - Assumptions should be based on data.
 - *Probabilistic* terrorism modeling allows most comprehensive view of risk.
- Capable terrorists are rational actors whose targeting selections align with principals maximizing “attack leverage”
- Location-level data quality is important due to small event footprints
- Data for terrorism modeling is much better today than 15 years ago. But insuring terrorism risk will always be difficult.



ABOUT RMS

RMS is the world's leading provider of products, services, and expertise for the quantification and management of catastrophe risk. More than 400 leading insurers, reinsurers, trading companies, and other financial institutions rely on RMS models to quantify, manage, and transfer risk. As an established provider of risk modeling to companies across all market segments, RMS provides solutions that can be trusted as reliable benchmarks for strategic pricing, risk management, and risk transfer decisions.

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