PRICING TORNADOES: USING CAT MODELS FOR GRANULAR RISK UNDERWRITING

Kevin Van Leer, Product Manager – Americas Climate

National Tornado Summit – Oklahoma City, OK

February 24, 2015

PURPOSE OF RMS

Tool for the Insurance Industry to help with:

Underwriting

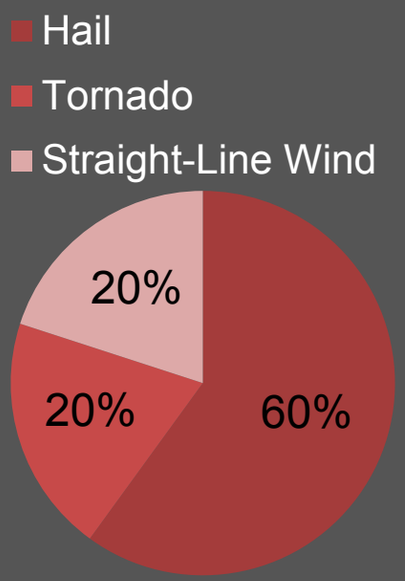
Portfolio Management

Risk Transfer

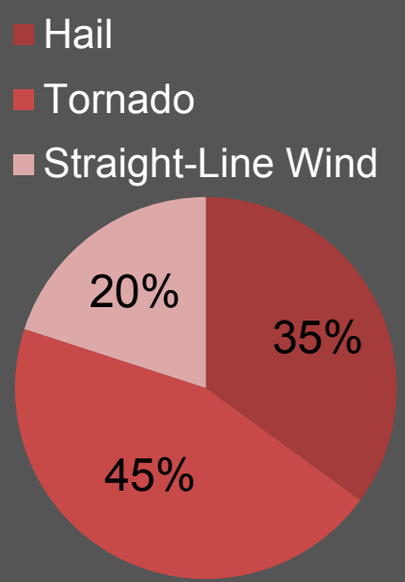
WHY MODEL TORNADO RISK?

OVERALL SEVERE CONVECTIVE STORM RISK

AAL



100-Year RP



Perils

- Tornado
- Hail
- Straight-Line Wind
- Lightning

Risk

- High Risk to:
  - Aggregate Covers
  - Automobile Lines
  - Large Single Location Risks
  - SFD, MFD, Mobile Home, Commercial, etc.

Loss

- 1/3 of U.S. peril Average Annual Loss (AAL)
- 92% chance of a $1BN event in the U.S. every year
- Two $7BN events in 2011
- Tornadoes drives tail return period (RP) losses; Hail drives AAL

HOW DOES RMS MODEL TORNADO RISK?

FIRST, YOU HAVE TO ANSWER:

WHAT IS THE PROBABILITY OF A TORNADO IMPACTING OKLAHOMA CITY, OK?

HISTORICAL CHALLENGES - OBSERVATIONS

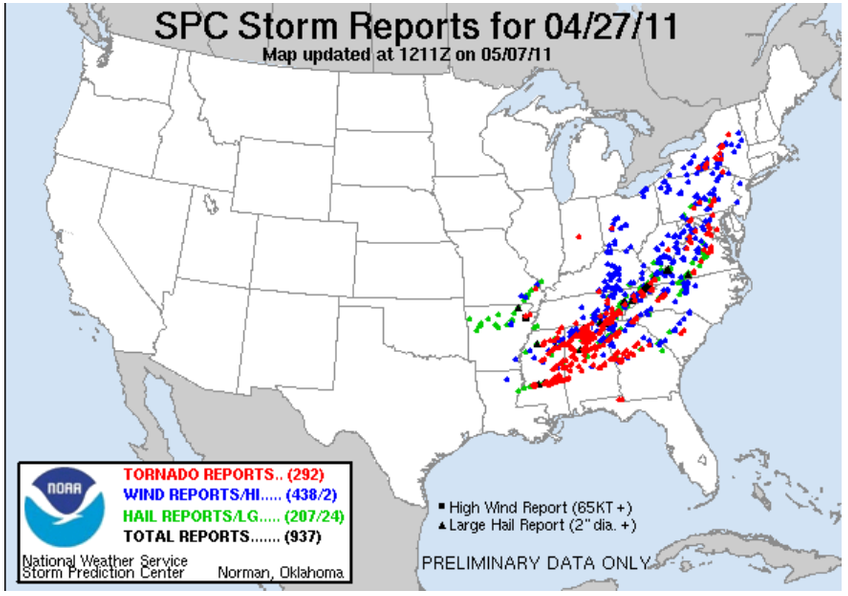
Cons

- Point estimates
- Human observations
- Few night-time observations
- Reporting methods differ between NWS offices

Tornado Observations

Pros

- Relatively long database
- Detailed location data
- Assimilated from multiple sources



HISTORICAL CHALLENGES - CLAIMS

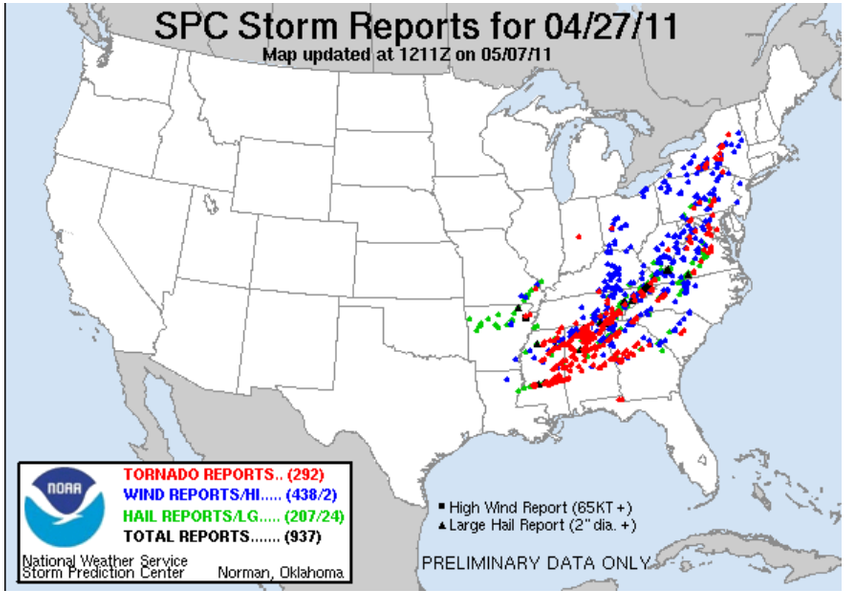
Cons

- Point estimates
- Human observations
- Reporting methods differ between insurers
- Typically only a “wind” claim

Tornado Claims

Pros

- Location data
- Damage information

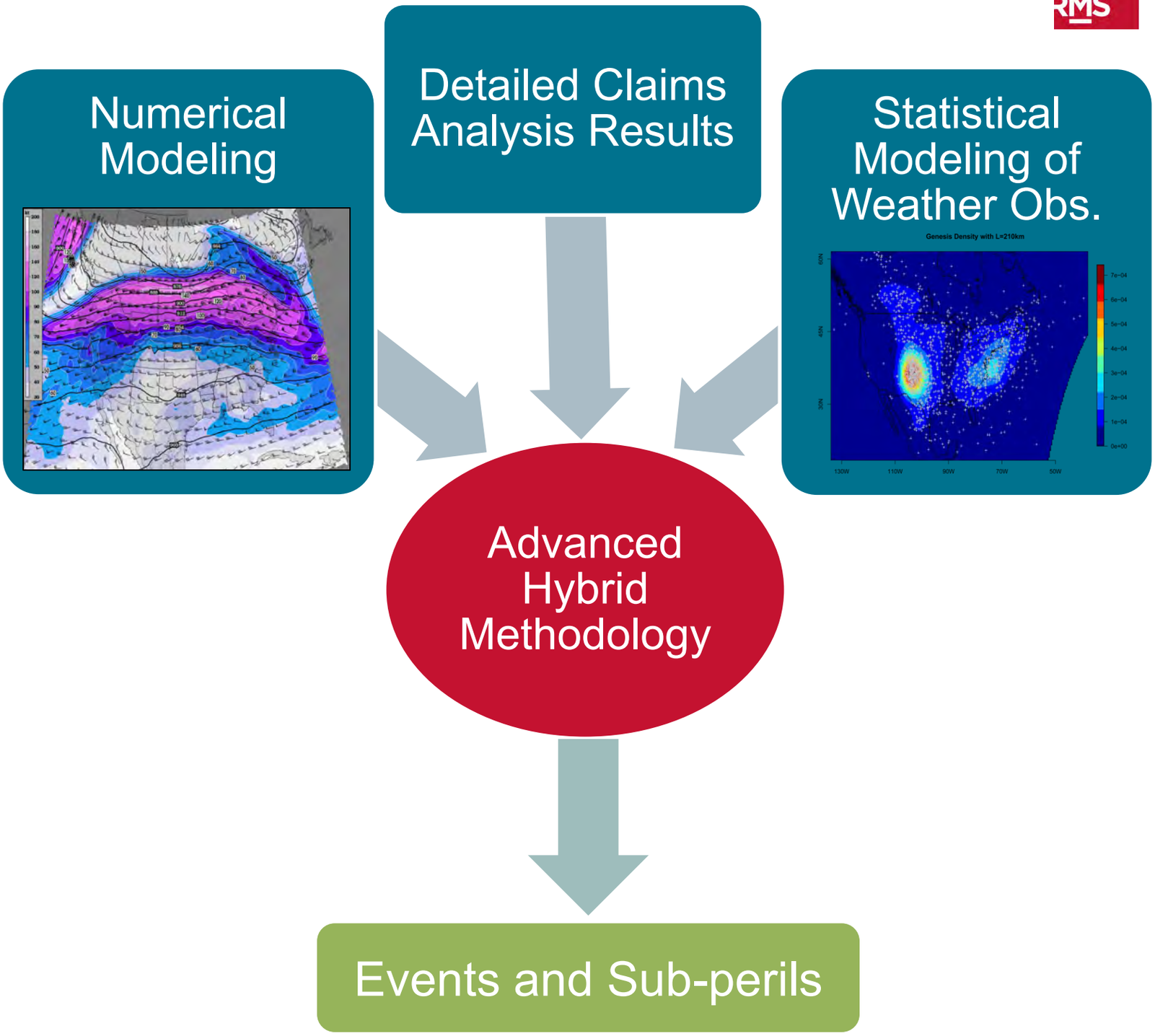


TORNADO RISK MODELING CHALLENGES

GENERATING AN EVENT CATALOGUE

WHY A HYBRID APPROACH?

- Fills in the gaps associated with incomplete claims and historical data records
- Allows RMS to model the spatial distribution of events more accurately
- Identifies areas of emerging risk
- Implicitly captures the behavior of event clustering



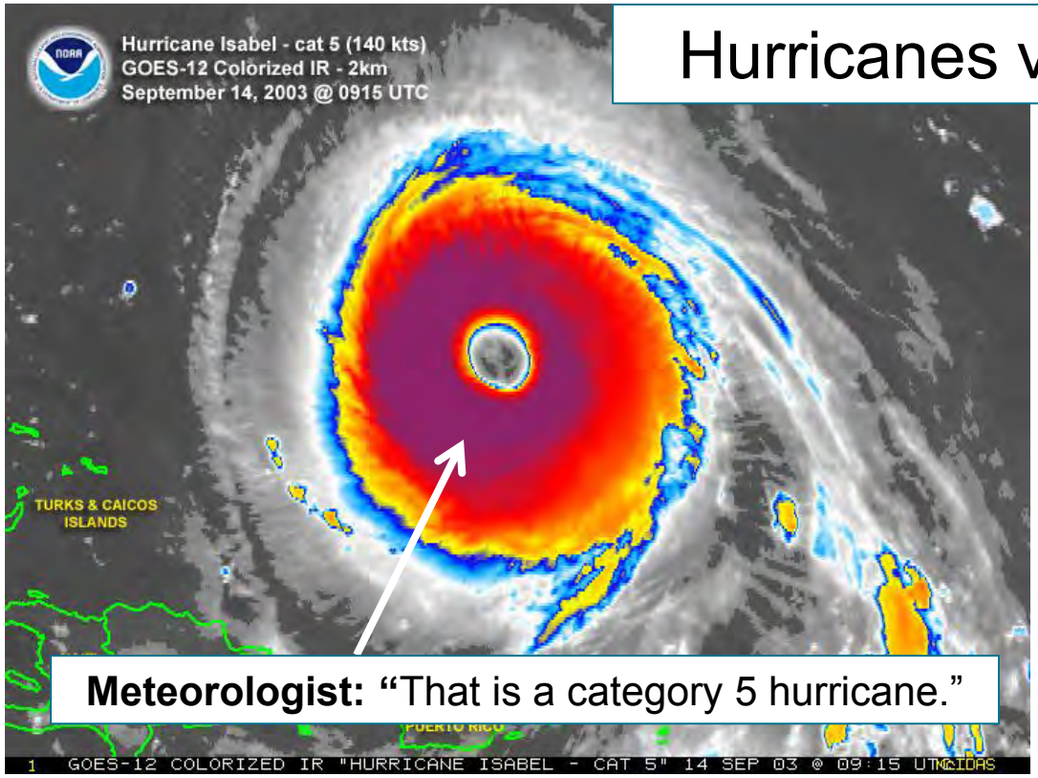
WHAT IS THE PROBABILITY OF AN EF-3 TORNADO IMPACTING OKLAHOMA CITY, OK?

WHAT IS THE PROBABILITY OF AN EF-3 TORNADO IMPACTING OKLAHOMA CITY, OK?

How is this defined?

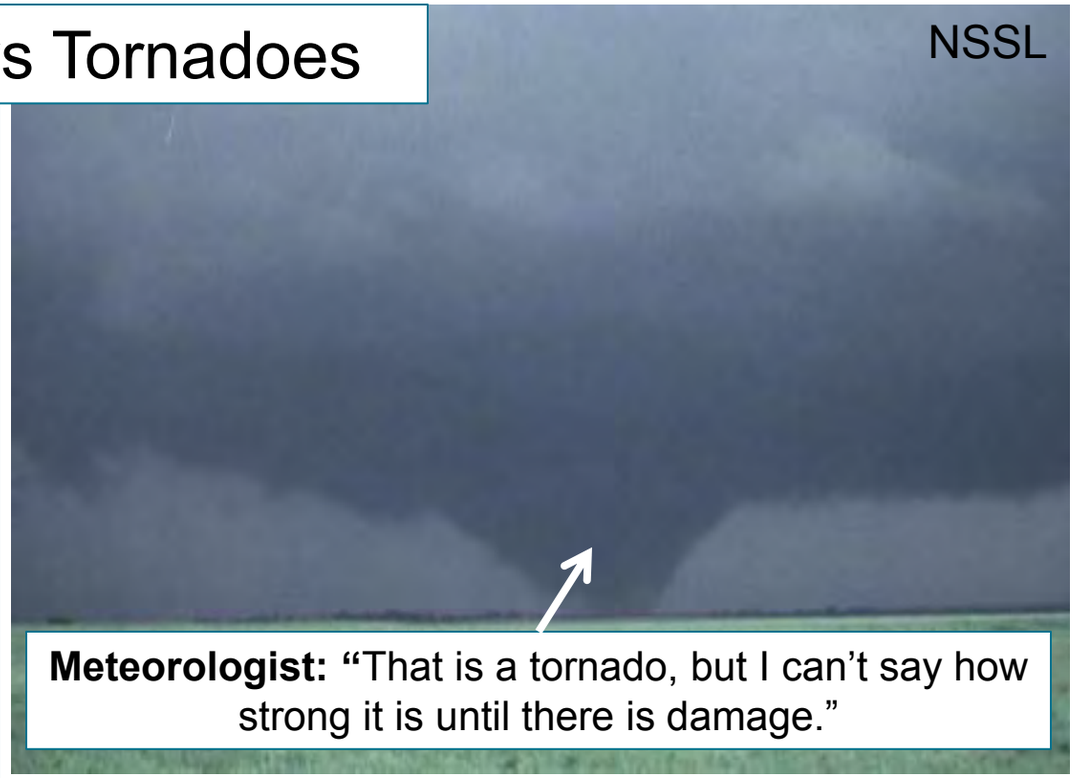
HOW DO WE DEFINE TORNADO HAZARD?

Hurricanes vs Tornadoes



Meteorologist: "That is a category 5 hurricane."

- Designated using satellite, aircraft recon, radar, and other **observations** to determine peak 1-min sustained wind speed at 10 meters
- Wind speed maps directly to the Saffir-Simpson Hurricane Wind Scale



Meteorologist: "That is a tornado, but I can't say how strong it is until there is damage."

- Wind speed is estimated using **damage** from the tornado, not direct observations
- Damage maps to ranges of wind speed
- Wind speeds map to the Enhanced Fujita Scale

EF-SCALE

- Originally developed as the Fujita scale in 1971
- Enhanced Fujita (EF) Scale adopted in 2007
- The F and EF-scale ratings were kept nearly the same for historical record consistency
- 28 Damage Indicators (U.S. Version)

Fujita Scale		Enhanced Fujita Scale* * In use since 2007	
F–0	40–72 mph winds	EF–0	65–85 mph winds
F–1	73–112 mph	EF–1	86–110 mph
F–2	113–157 mph	EF–2	111–135 mph
F–3	158–206 mph	EF–3	136–165 mph
F–4	207–260 mph	EF–4	166–200 mph
F–5	261–318 mph	EF–5	>200 mph

Damage Indicators	Abbreviation
Small barns, farm outbuildings	SBO
One- or two-family residences	FR12
Single-wide mobile home (MHSW)	MHSW
Double-wide mobile home	MHDW
Apt, condo, townhouse (3 stories or less)	ACT
Motel	M
Masonry apt. or motel	MAM
Small retail bldg. (fast food)	SRB
Small professional (doctor office, branch bank)	SPB
Strip mall	SM
Large shopping mall	LSM
Large, isolated ("big box") retail bldg.	LIRB
Automobile showroom	ASR
Automotive service building	ASB
School - 1-story elementary (interior or exterior halls)	ES
School - jr. or sr. high school	JHSH
Low-rise (1-4 story) bldg.	LRB
Mid-rise (5-20 story) bldg.	MRB
High-rise (over 20 stories)	HRB
Institutional bldg. (hospital, govt. or university)	IB
Metal building system	MBS
Service station canopy	SSC
Warehouse (tilt-up walls or heavy timber)	WHB
Transmission line tower	TLT
Free-standing tower	FST
Free standing pole (light, flag, luminary)	FSP
Tree - hardwood	TH
Tree - softwood	TS

DAMAGE INDICATORS

- Contain degrees of damage (DOD) that correspond to damage descriptions and wind speeds ranges
- This information provides a basis for developing a vulnerability curve

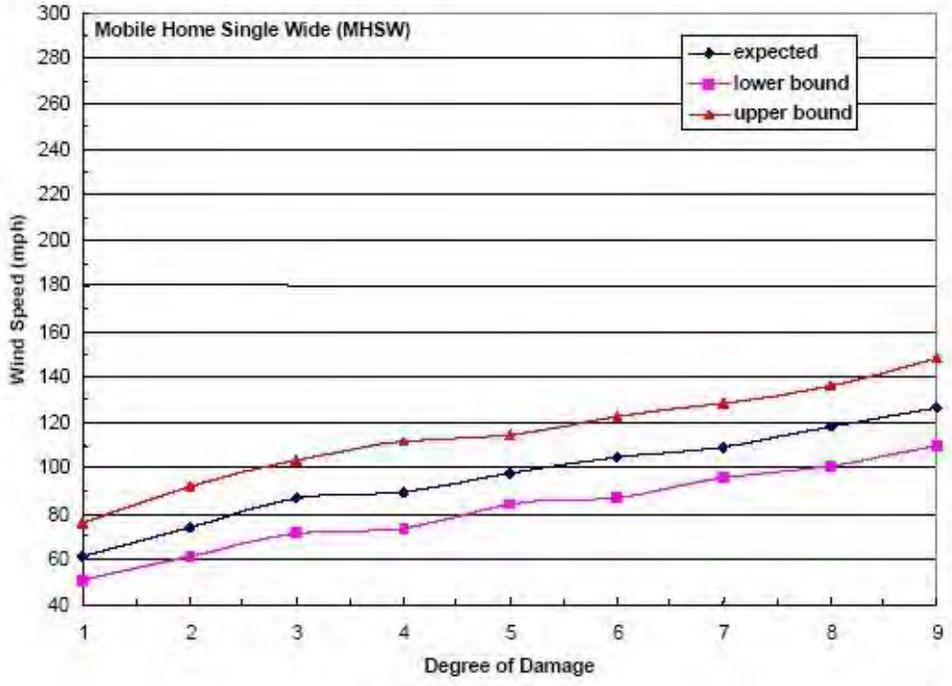
3. MANUFACTURED HOMES – SINGLE WIDE (MHSW)

Typical Construction

- Steel undercarriage supported on concrete block piers
- Metal straps and ground anchors (Frame and/or over-the-top strap anchors
- Asphalt shingles or one-piece metal roof covering
- Wood roof joists
- Metal, vinyl, or wood siding
- Wood roof joists
- Wood stud walls and partitions
- Better construction in post 1974 models in coastal areas

DOD*	Damage description	EXP	LB	UB
1	Threshold of visible damage	61	51	76
2	Loss of shingles or partial uplift of one-piece metal roof covering	74	61	92
3	Unit slides off block piers but remains upright	87	72	103
4	Complete uplift of roof; most walls remain standing	89	73	112
5	Unit rolls on its side or upside down; remains essentially intact	98	84	114
6	Destruction of roof and walls leaving floor and undercarriage in place	105	87	123
7	Unit rolls or vaults; roof and walls separate from floor and undercarriage	109	96	128
8	Undercarriage separates from unit; rolls, tumbles and is badly bent	118	101	136
9	Complete destruction of unit; debris blown away	127	110	148

* Degree of Damage



WHAT IS THE PROBABILITY OF AN EF-3 TORNADO IMPACTING OKLAHOMA CITY, OK?

This is relatively simple to answer, but provides very little value!

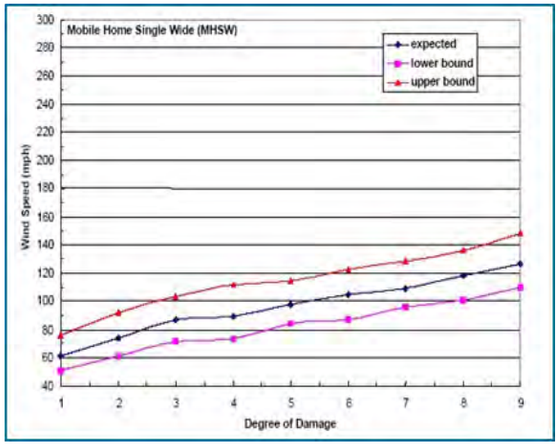
WHAT ARE THE ACTUAL **APPLICATIONS** OF THE EF-SCALE AND THE HISTORICAL RECORD?

WHAT IS THE PROBABILITY OF A TORNADO CAUSING 30% DAMAGE TO A 2-STORY WOOD FRAME SINGLE FAMILY DWELLING IN OKLAHOMA CITY, OK?

This is much more valuable!

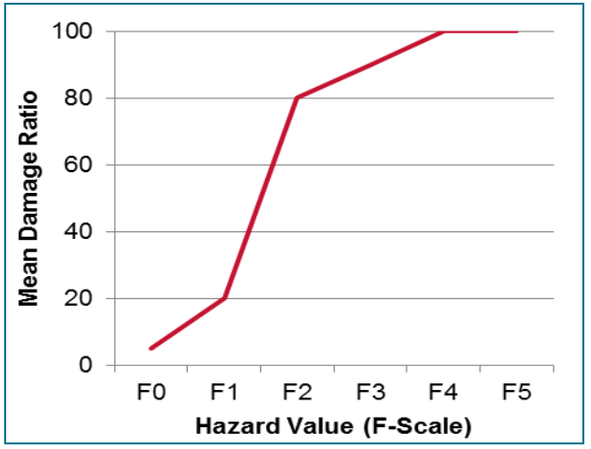
HOW VULNERABLE IS THAT BUILDING?

EF-Scale Damage Curve → Generate Damage Ratios → Calibration → RMS Vulnerability Curve



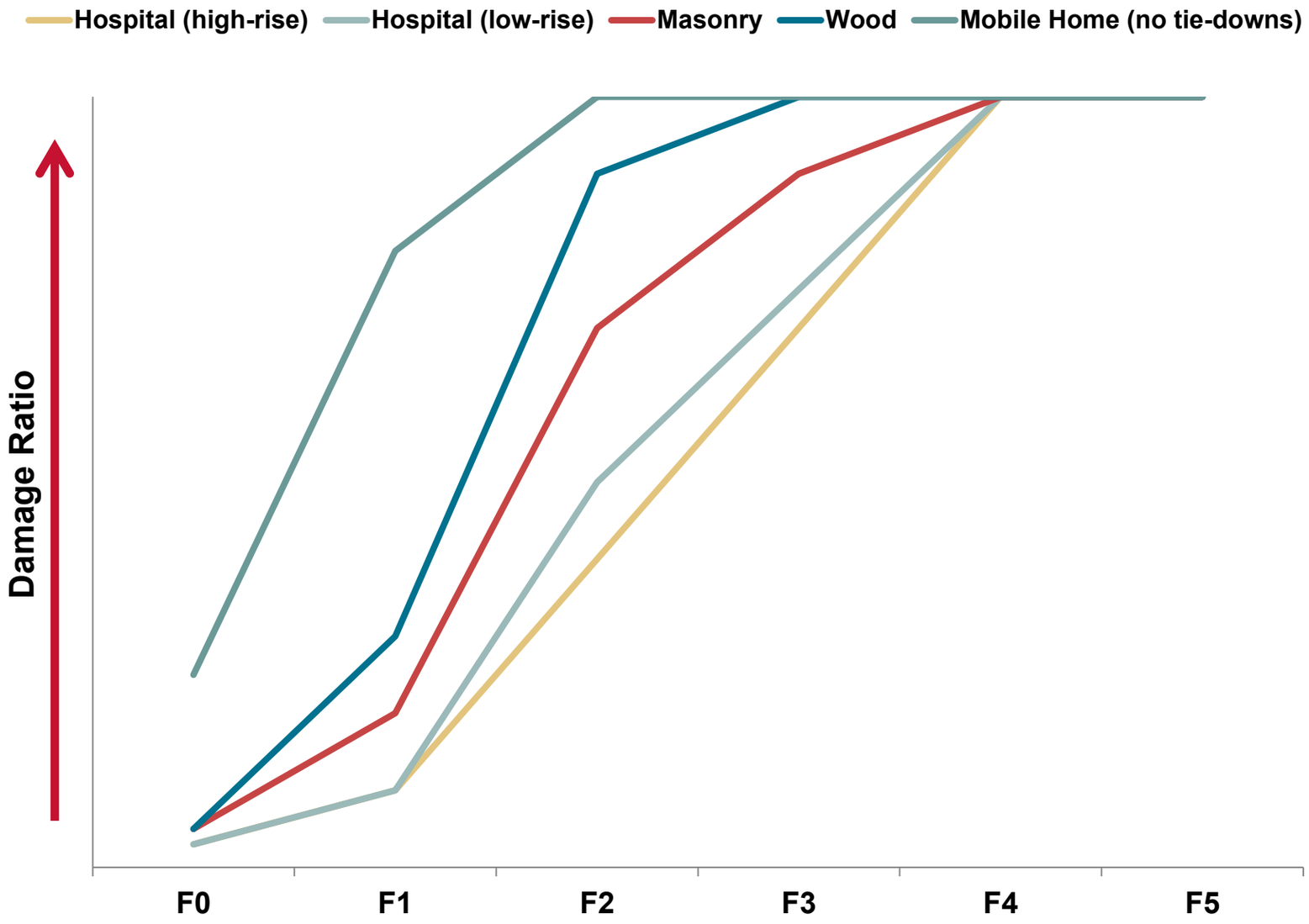
- Evaluate building characteristics and values
- Determine % of building value damaged (i.e. roof, siding

- Academic Research
  - Wind Tunnels
  - Damage Surveys
  - Papers
- Sanity Checks



HOW DO DIFFERENT TYPES OF BUILDINGS PERFORM?

- Many factors influence vulnerability:
  - Construction
  - Occupancy
  - Location
  - Mitigation (e.g. roof anchors, foundation connections)
- Many lines of business are at or near 100% damage at EF3 intensity



- Underwriting
- Determining Risk Drivers
- Mitigation Cost-Benefit Analysis
- Building Code Analysis
- Risk Transfer

RISK MANAGEMENT APPLICATIONS

- CAT models provide the ability to differentiate between exposures
- Answers the questions for both tornado hazard and vulnerability

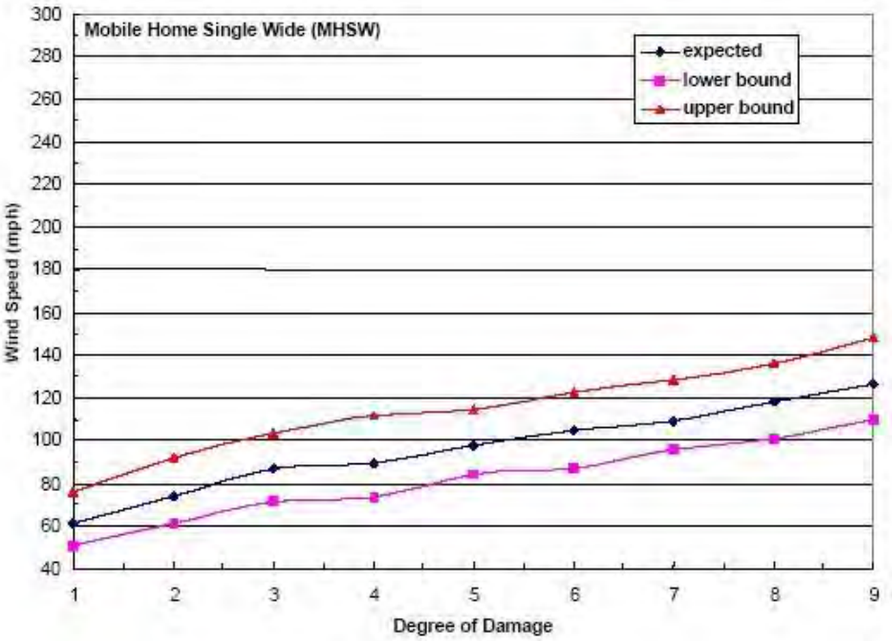
Scenario	Construction	Occupancy	Yr Built	# of Stories	AAL
1	Unknown	Unknown	Unknown	Unknown	$82
2	Wood	Unknown	Unknown	Unknown	$107
3	Wood	SFD	Unknown	Unknown	$123
4	Wood	SFD	1995	Unknown	$113
5	Wood	SFD	1995	2	$97

Example numbers from a specific exposure geographic and attribute combination

HOW CAN WE IMPROVE?

IT STARTS WITH THE EF-SCALE!

- The scale is overly precise
- Wind speeds do not always increase with increasing DOD
- Overlapping DODs
- What about construction quality guidance?



DOD*	Damage description	EXP	LB	UB
1	Threshold of visible damage	61	51	76
2	Loss of shingles or partial uplift of one-piece metal roof covering	74	61	92
3	Unit slides off block piers but remains upright	87	72	103
4	Complete uplift of roof; most walls remain standing	89	73	112
5	Unit rolls on its side or upside down; remains essentially intact	98	84	114
6	Destruction of roof and walls leaving floor and undercarriage in place	105	87	123
7	Unit rolls or vaults; roof and walls separate from floor and undercarriage	109	96	128
8	Undercarriage separates from unit; rolls, tumbles and is badly bent	118	101	136
9	Complete destruction of unit; debris blown away	127	110	148

* Degree of Damage

WHAT ARE THE NEXT STEPS?

- Can we round the wind speeds?
  - HURDAT rounds to the nearest 5 knots
- Combined DODs?
- Cumulative DODs?
- Construction Quality Guidance?

WHAT ARE THE NEXT STEPS?

- Can we round the wind speeds?
  - HURDAT rounds to the nearest 5 knots
- Combined DODs?
- Cumulative DODs?
- Construction Quality Guidance?
- Mitigation
  - Community mitigation can “shrink the damage path”
  - How do we account for building code variation?

WHAT ARE THE NEXT STEPS?

- Can we round the wind speeds?
  - HURDAT rounds to the nearest 5 knots
- Combined DODs?
- Cumulative DODs?
- Construction Quality Guidance?
- Mitigation
  - Community mitigation can “shrink the damage path”
  - How do we account for building code variation?

- **Where do we go from here?**
  - ASCE Committee for Wind Speed Estimation in Tornadoes
  - Work to improve the scale to better match its applications

Email: kevin.vanleer@rms.com

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.