PRICING TORNADOES: USING CAT MODELS FOR GRANULAR RISK UNDERWRITING

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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

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
- Tornado drives tail return period (RP) losses; Hail drives AAL

AAL
- Hail
- Tornado
- Straight-Line Wind

100-Year RP
- Hail
- Tornado
- Straight-Line Wind

FIRST, YOU HAVE TO ANSWER:
WHAT IS THE PROBABILITY OF A TORNADO IMPACTING OKLAHOMA CITY, OK?
**HISTORICAL CHALLENGES - OBSERVATIONS**

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

**Cons**
- Point estimates
- Human observations
- Few nighttime observations
- Reporting methods differ between NWS offices

**HISTORICAL CHALLENGES - CLAIMS**

**Pros**
- Location data
- Damage information

**Cons**
- Point estimates
- Human observations
- Reporting methods differ between insurers
- Typically only a "wind" claim

**TORNADO RISK MODELING CHALLENGES**

**Challenges**
- Limited Historical Record
- Few in-situ observations
- Intensity estimate requires damage
- Small Footprints

**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

**GENERATING AN EVENT CATALOGUE**

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

How is this defined?
HOW DO WE DEFINE TORNADO HAZARD?

- 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
- Wind speed is estimated using damage from the tornado, not direct observations
- Wind speeds map to the Enhanced Fujita Scale

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

DAMAGE INDICATORS

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

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?

- Risk Assessment
- Scientific Research
- Mitigation Design
- Media
- Building Codes

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?

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

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

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

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

RISK MANAGEMENT APPLICATIONS

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

Underwriting
- Determining Risk Drivers

Mitigation Cost-Benefit Analysis
- Building Code Analysis
- Risk Transfer

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?

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?
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- 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

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ABOUT RMS

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