CoreLogic®

Cat Modeling 101

CAS U/W Collaboration Seminar

Boston, MA

March 25, 2018

Agenda
Subtitle here

- American Academy of Actuaries publications
  - Genesis of papers
  - Structure of catastrophe modeling monograph

- Focus on the types of catastrophe models, and the use cases for all of them
  - Deterministic models
  - Probabilistic models
  - Forensic models

American Academy of Actuaries Publications

Catastrophe Model Solutions

Background

- Academy monograph, April 2017, *The National Flood Insurance Program: Challenges and Solutions* http://www.actuary.org/files/publications/FloodMonograph.04192017.pdf
- Questions arose in response to paper
- Lack of documentation within the actuarial framework around natural catastrophe models

- Resulting new Academy monograph, July 2018, Uses of Catastrophe Model Output http://www.actuary.org/files/publications/Catastrophe_Modeling_Monograph_07.25.2018.pdf

- Members of Drafting Subcommittee
  - Kay Cleary, MAAA, FCAS, FCA, Chairperson
  - Minchong Mao, MAAA, FCAS, FSA
  - Trevar Withers, MAAA, ACAS
  - Edward Ford, MAAA, FCAS
  - Howard Kunst, MAAA, FCAS

Structure of the Paper

- Focus on providing a basic description of natural catastrophe model design and uses
  - Basic structure of a model
    - Only covered Probabilistic models
  - Major use cases
    - Includes examples to illustrate
- Focus on Output, not Science
  - Science varies between models
  - Focus on Probabilistic/Stochastic model, as outputs (Average Annual Losses (AALs), Probable Maximum Losses (PMLs)) are relatively similar between models
    - Event set, with frequencies and event characteristics
    - Damage model
    - Financial calculations

Perils Covered

- Selected a varied set of perils to demonstrate some of the similarities and differences
  - Hurricane
  - Inland Flood
  - Coastal Flood (tropical storm surge)
  - Hail (Severe Convective Storm)

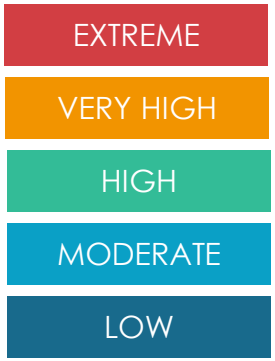
- Representation Portfolio used
- Developed a random set, based on the population by ZIP code in Florida
  - 100,000 locations
  - Random parcels selected
  - Same set used for all perils

Main Areas Covered in the Paper

- Model Governance
- *Ratemaking*
- *Underwriting and Risk Selection*
- Mitigation
- *Reinsurance*
- Advantages and Limitations of the Models

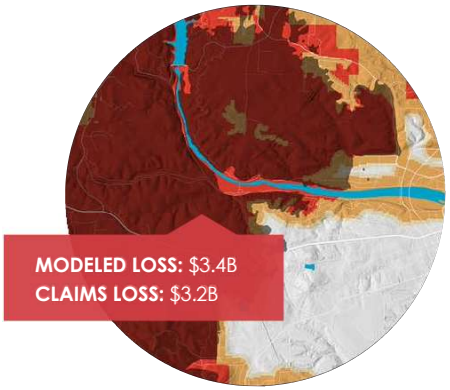
Models and Their Corresponding Uses

Types of Natural Catastrophe Models



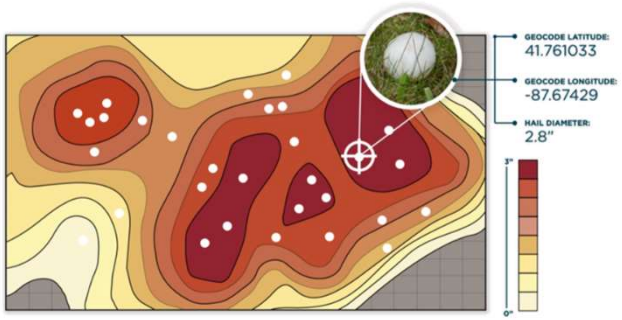
DETERMINISTIC

What could happen?



PROBABILISTIC

What if it happened?

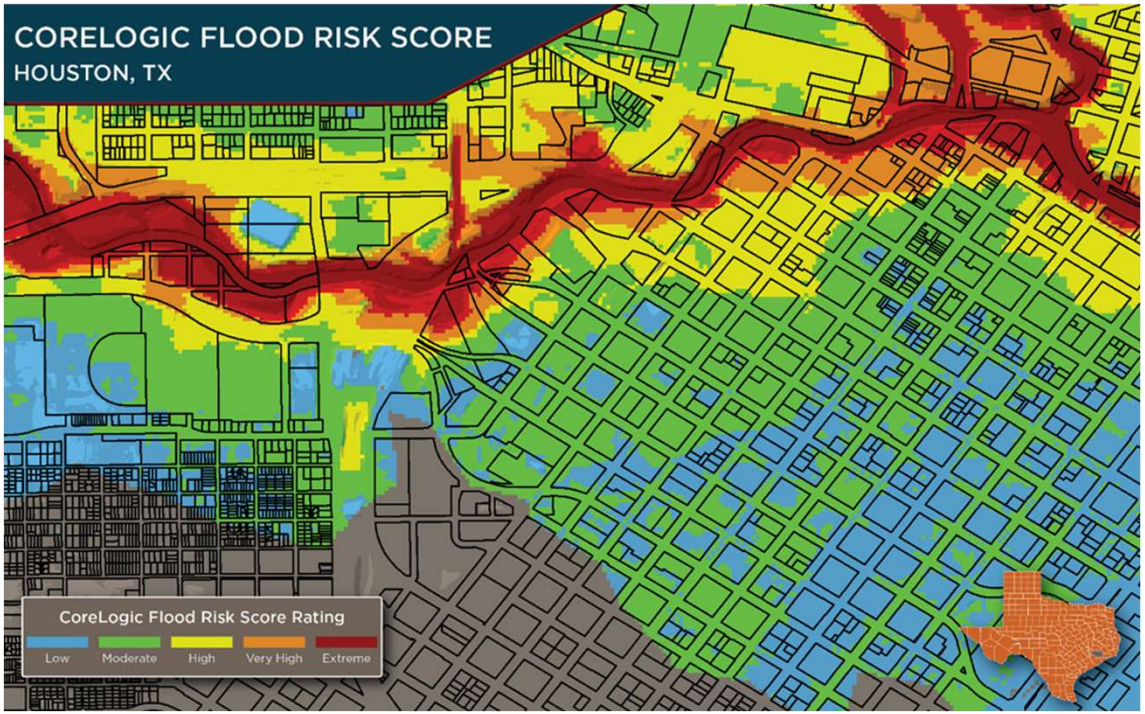


FORENSIC

What did happen?

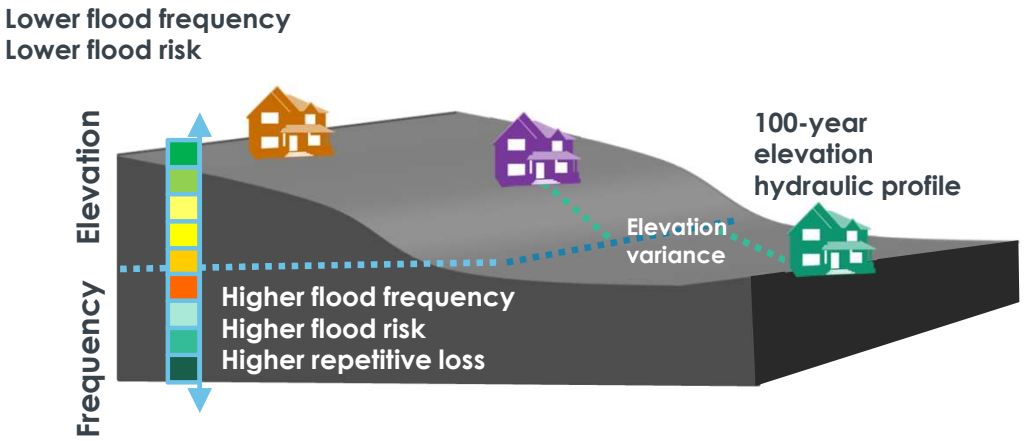
Types of Natural Catastrophe Models
Deterministic Models

- Provides a score (1-100) that represents the relative risk for a specific peril, at a specific location
- May only be relative to the hazard, while some include a measure of estimated loss based on the structure present



Types of Natural Catastrophe Models

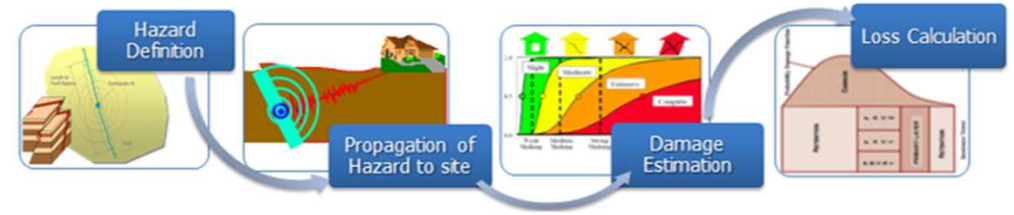
Deterministic Models – Flood Risk Score



- Create comprehensive spectrum of flood risk classifications
  - Above/below 100-year flood elevation, up to 5,000-year flood event
  - 10–100 score
- Compare unknown (targeted property elevation) with known risk point (100-year flood elevation)
  - Derive risk scores based on elevation variances (elevation difference between 100-year elevations and property elevations)
- The challenge: to build 100-year flood surface profile to cover national rivers, lakes, coastal zones and other water bodies

Types of Natural Catastrophe Models
Probabilistic Models

- Start with a large event set (historical and simulated); each event has a frequency of occurrence
- Based on characteristics of the event at any location, the structure vulnerability and associated loss can be calculated
- Outputs include:
  - Event Loss tables and Yearly Loss tables
  - AAL's and PML's



Event Catalog:
- Magnitude
  - How Big?
- Frequency
  - How Likely?
- Where?

Event Footprints:
- Ground Motion Distribution
- How Intense?
- Attenuation Functions
- Soil Maps
- Site Adjustments

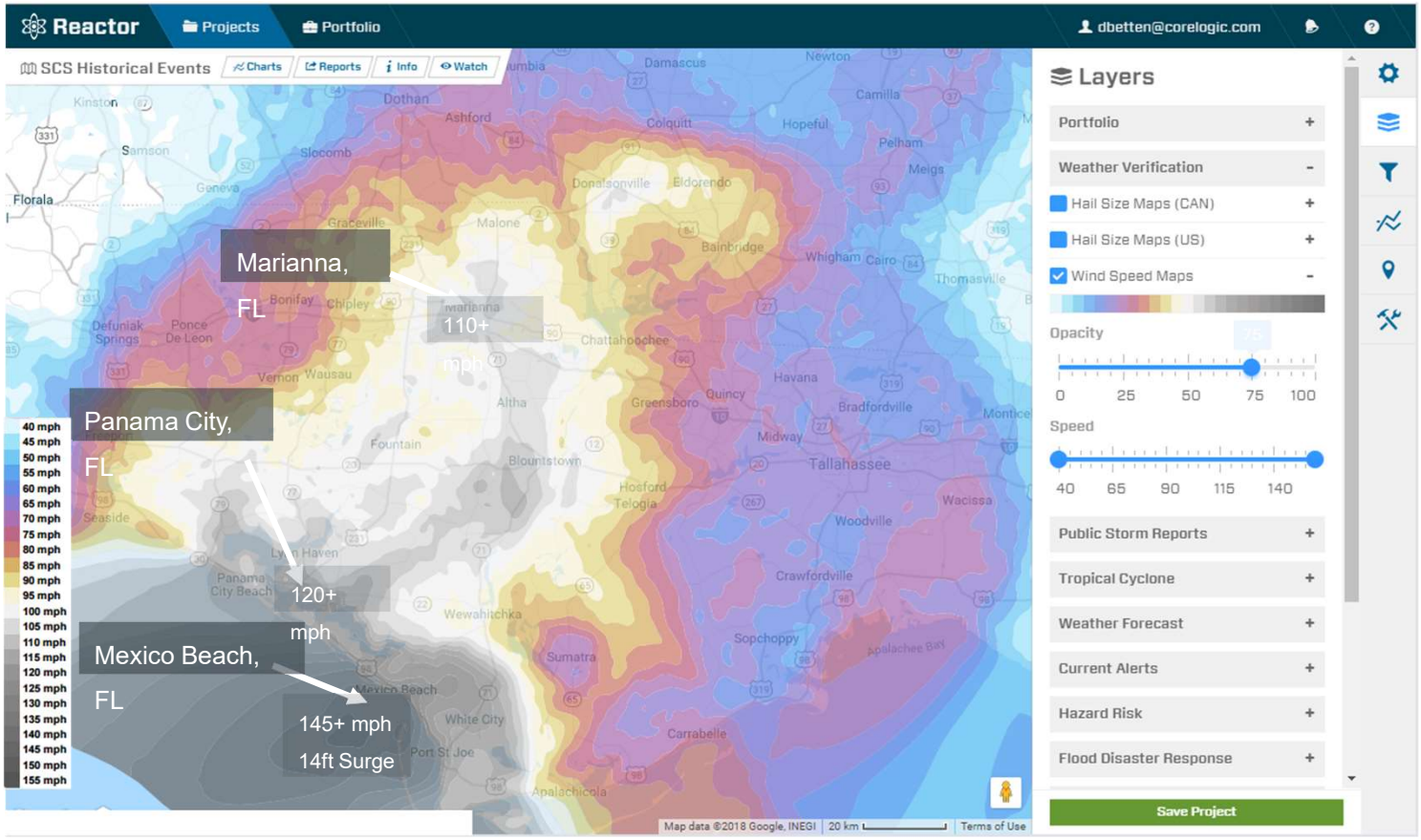
Vulnerability:
- Construction
- Occupancy
- Coverage
- Sub-Peril (Shake, Fire, Sprinkler, tsunami)
- Demand Surge

Losses:
- Policy Terms
- Validation
- LAE, other adjustments

Types of Natural Catastrophe Models
Forensic Models

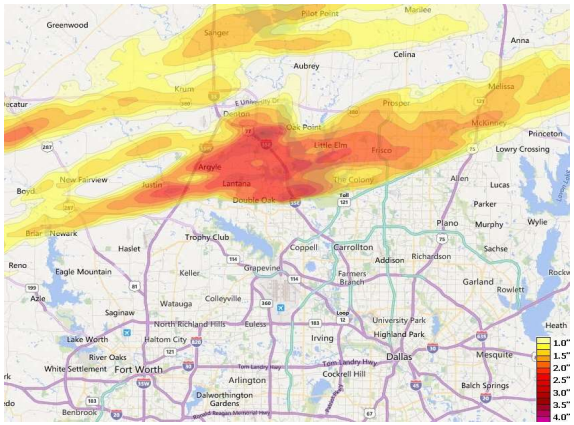
- Post event analysis of what occurred
- Advanced radar
- Aerial imagery

CoreLogic Windspeed Map for Hurricane Michael



Modeling Historical Hail Events
Individual Event Representation

Public Hail Reports (Green H's) – Dallas, TX 3/26/17
Source: Storm Prediction Center



Hail Size Map – Dallas, TX 3/26/17
Source: CoreLogic Reactor™

- **Public Report Based**
  - Storm Prediction Center (SPC) → incomplete and spatially inconsistent view of hail frequency
  - Hail storm size not captured, limits spatial granularity of hail frequency
  - Hard to accurately breakdown hail frequency by size

- **Forensic Algorithm Based**
  - Realistic, high-resolution hail footprints derived from proprietary radar-based weather forensic algorithm
  - Footprints derived from weather radar data + public data + social media reports
  - Every footprint is analyzed and quality controlled by our team of expert meteorologists

Industry Use Cases for Types of Models

Screening (Underwriting/Risk Selection)

- **Deterministic Risk Scores** [Most Common]
  - A good representation of relative risk, i.e., the higher the score the greater the risk. Depending on their risk appetite, an individual company can set its own thresholds for underwriting decisions
  - Score can be easily implemented/imported into U/W work stream, especially for homogenous lines of business
  - No need to run more sophisticated model

- **Probabilistic Model Results**
  - More complicated risks (e.g., larger commercial structures) may require more information
  - Understanding impacts of tail events
  - Impact on reinsurance placement / capital management

Pricing (Setting Rates/Premiums)

- **Deterministic Risk Scores**
  - Hazard risk scores provide a good representation of relative risk; a risk score can be translated into a rate relativity (relativity factor increases as score increases)
  - Score can be easily implemented/imported into a rating algorithm, especially for homogenous lines of business (law of large numbers)

- **Probabilistic Model Results**
  - More complicated risks (e.g., larger commercial structures) may require more information
  - Understanding impacts of tail events – Risk loads in addition to Avg Annual Loss
  - Building attributes are considered when calculating results – no need for any additional sets of rating factors when dealing with less homogenous structure types

Portfolio Risk/Capital Management/Reinsurance

- **Deterministic Risk Scores**
  - Hazard risk scores provide a method to look at the distribution of risk across various geographies

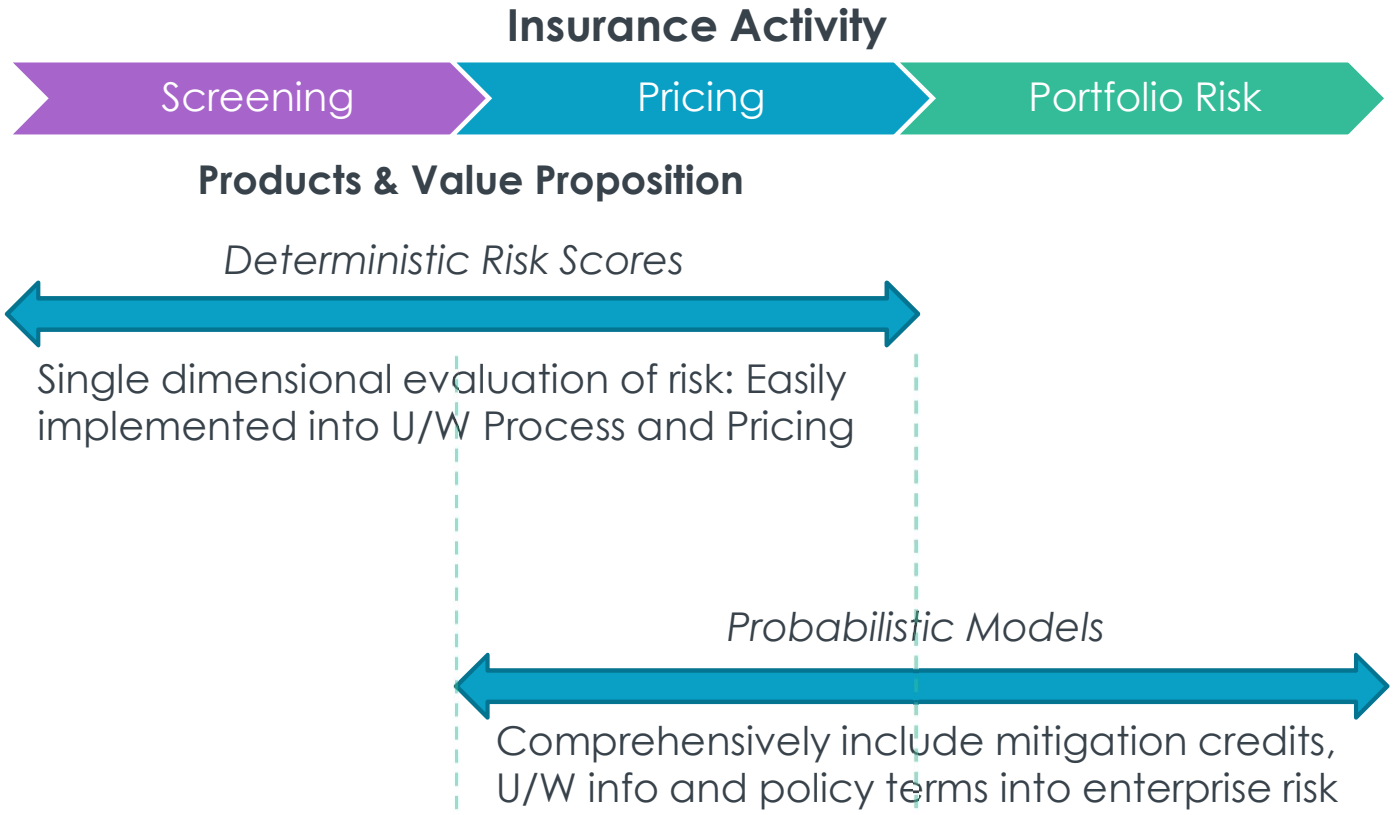
- **Probabilistic model results**
  - AALs and PMLs provide necessary information for senior management at companies to make a number of financial decisions
  - Based on a selected return period (100-year loss), it can advise as to how much reinsurance to purchase, to cover potential large-event losses extending beyond what the company can retain
  - Scenario testing – identifying the events that have the highest potential impact to the company's financials, and making decisions that impact the company's portfolio of insureds
  - Capital allocation is sometimes based on the potential for extreme losses; i.e., portfolios with higher PMLs for a selected return period may draw more capital to support

Claims/Fraud Identification

- **Forensic Models**
  - Identifying the impacts of an event across the entire geographic footprint of the event
  - Understanding where the event occurred relative to insured portfolio allows company to triage claims resources
  - Can be used to verify coverage (i.e., did hail actually occur at a specific address)
  - In conjunction with vulnerability information from the probabilistic models, a reasonable first estimate of the total losses from an event can be made

Natural Catastrophe Offerings to Insurers

A Complete Suite of Products to Cover the Insurers' Needs



Catastrophe Model Use in **Mortgage**

From Underwriting to Portfolio Management

- **Deterministic Risk Scores** [U/W and Risk Selection]
  - Hazard risk scores provide a good representation of relative risk, i.e., the higher the score the greater the risk. Depending on their risk appetite, an individual company can set its own thresholds for underwriting decisions
  - Score can be easily implemented/imported into U/W work stream, especially for homogenous lines of business

- **Probabilistic Model Results**
  - Review AAL and PML
  - Mortgage impairment

Catastrophe Model Use in **Utilities**

Gas, Electric, Telecommunication

- **Deterministic Risk Scores**
  - Need to understand Natural catastrophe risks associated with assets, and which specific perils are present
- **Probabilistic Model Results**
  - Review AAL and PML; many of the structures Utilities have are unique and complex that require individual modeling

Catastrophe Model Use in **Government**

From Municipalities to Federal

- **Deterministic Risk Scores**
  - Hazard risk scores used to understand where the highest risk areas are within specific geographic boundaries (i.e. flood risk)
  - Community planning
  - Triage
- **Probabilistic Model Results**
  - Review PML information; what is the estimated loss for a 100 year event?