Introducing AIR's New Severe Thunderstorm Model for Europe

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Toward a Comprehensive View of Natural Perils Risk for Europe

Extratropical Cyclone

Flood

Severe Thunderstorm

Earthquake

Storm Surge

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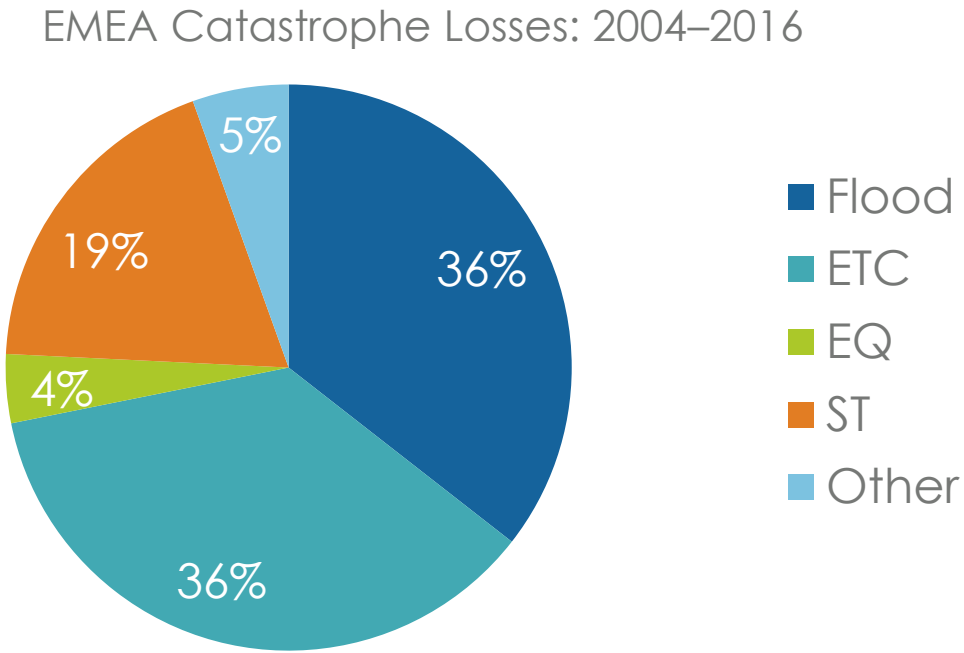
Agenda

- Model Overview
- Quantifying Severe Thunderstorm Hazard
- Modeled View of Severe Thunderstorm Hazard
- Vulnerability Component
- Modeled Losses

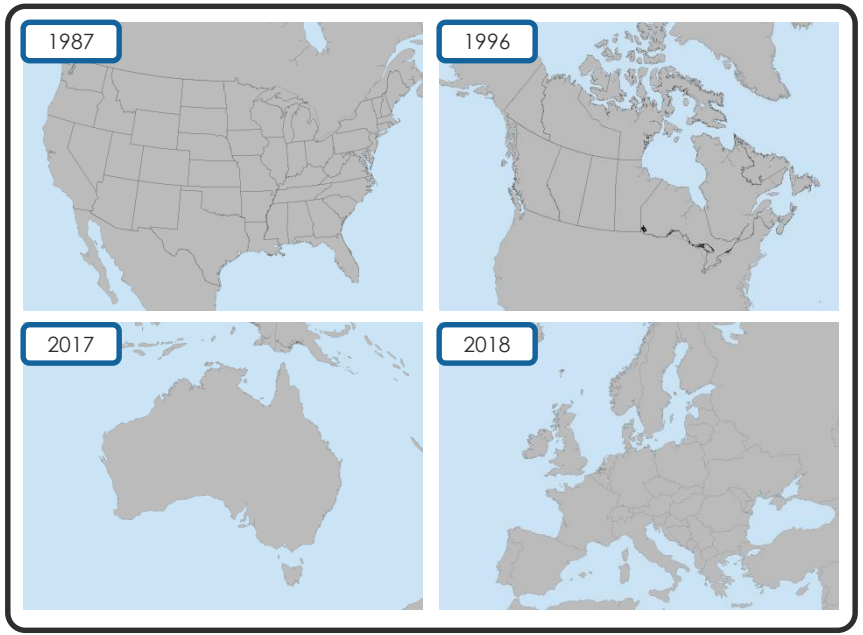
Addition of European Severe Thunderstorm Model Provides a More Comprehensive View of Risk



Source: Aon Benfield Catastrophe Insight

AIR Has Extensive Experience Modeling Severe Thunderstorms

Global Expertise



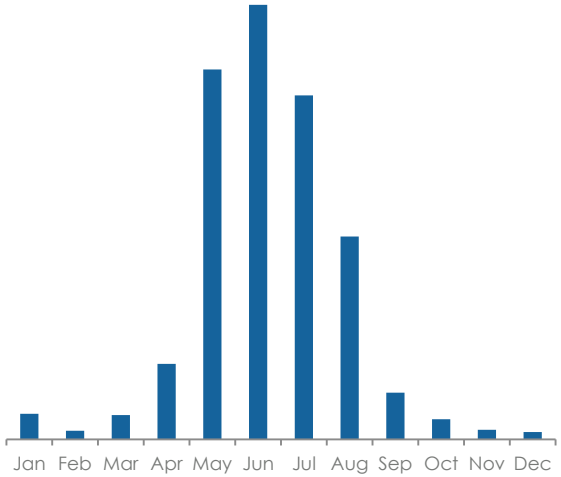
Leveraging Local Knowledge

- European Severe Weather Database (ESWD)
- Tornado and Storm Research Organization (TORRO)
- DWD (German Weather Service)
- EUMETNET (OPERA)
- European Center for Medium-Range Weather Forecasts (ECMWF)
- Karlsruhe Institute of Technology (KIT)

Model Coverage

Model Domain: 22 Countries

Year-Round Activity



Hail and Straight-Line Wind

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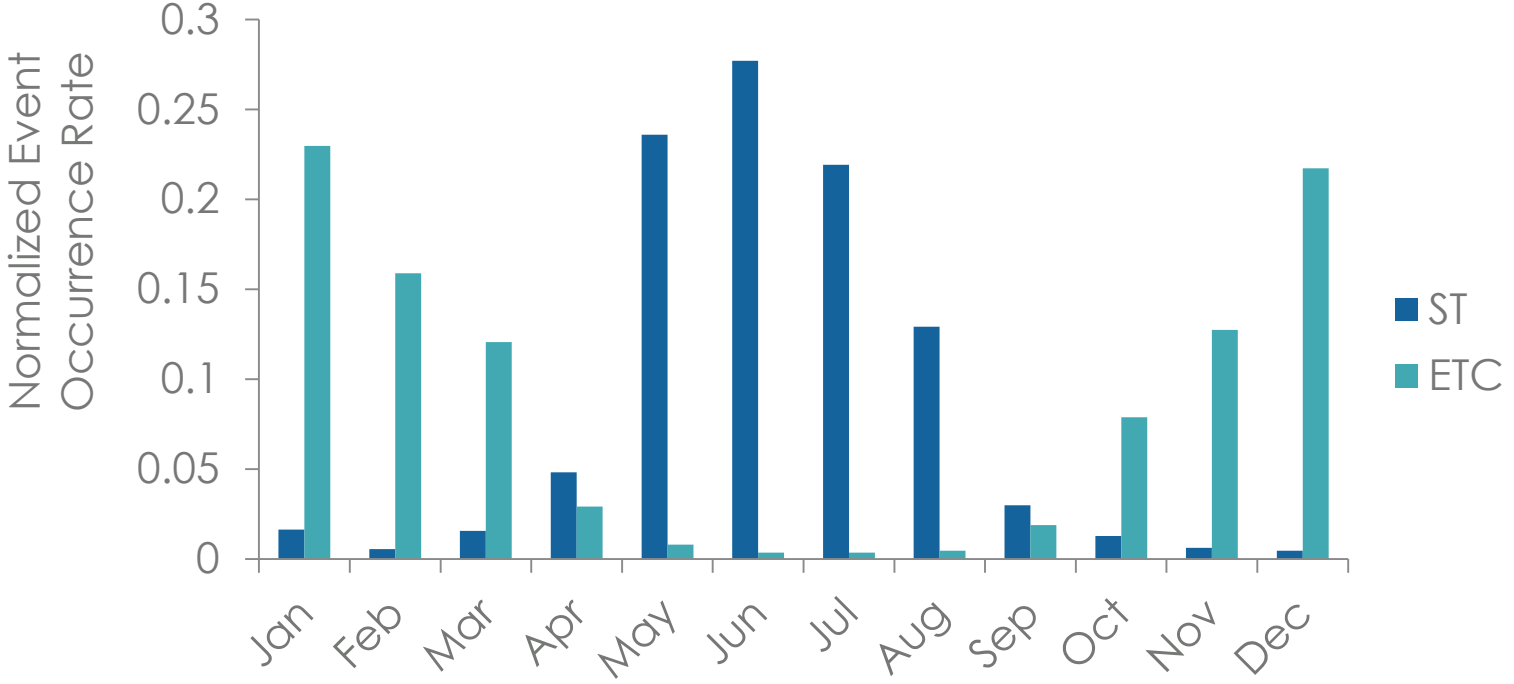
Severe Thunderstorm Is the Dominant Wind Peril in the Summer



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Quantifying Severe Thunderstorm Hazard

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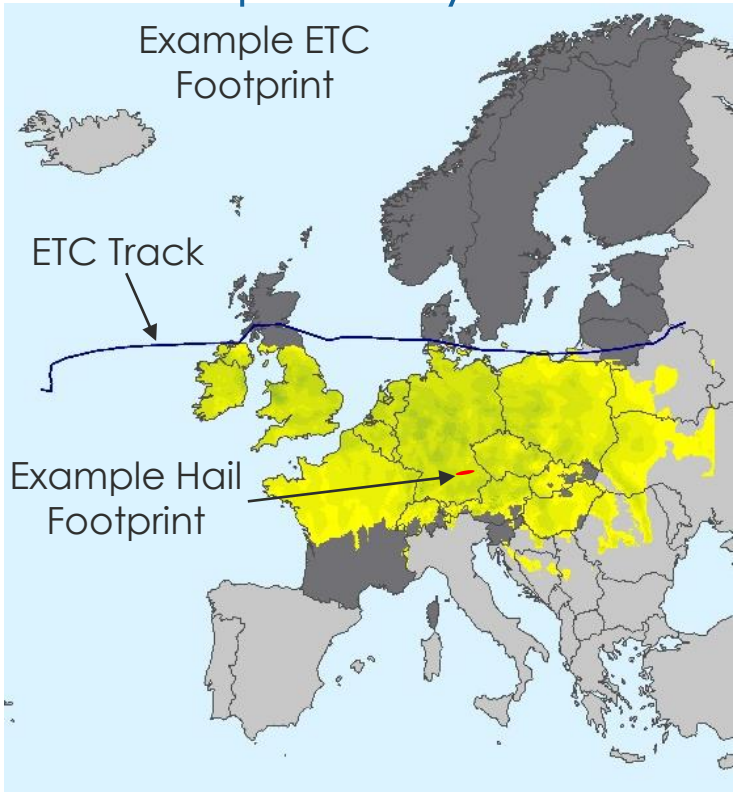
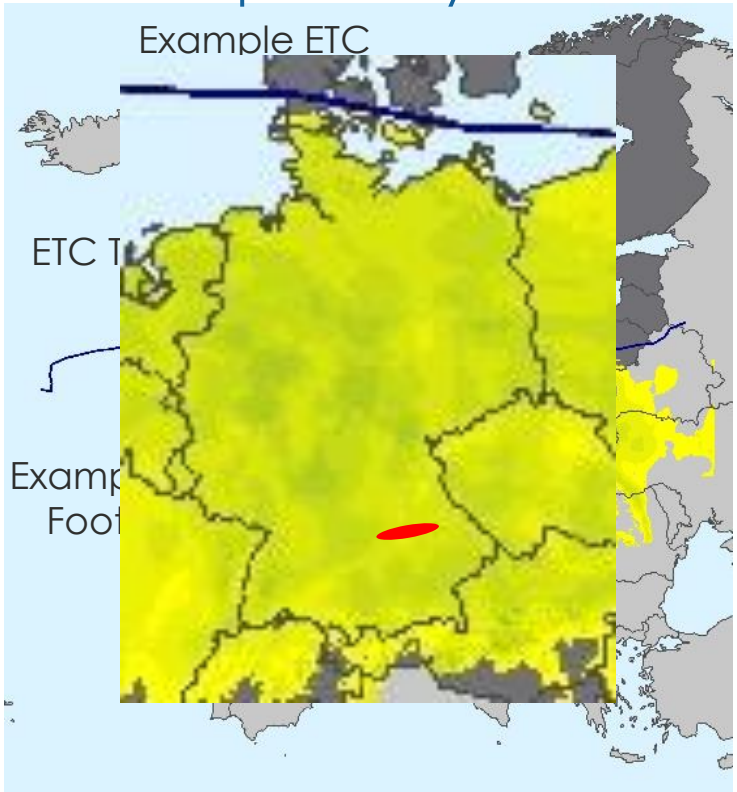
Severe Thunderstorms Are Smaller Scale Than Extratropical Cyclones



Compared to extratropical cyclones, severe thunderstorms:

- Have shorter durations
- Cover smaller areas
- Are difficult to resolve by standard NWP models and grid-based methods
- Can have highly localized damage

Severe Thunderstorms Are Smaller Scale Than Extratropical Cyclones



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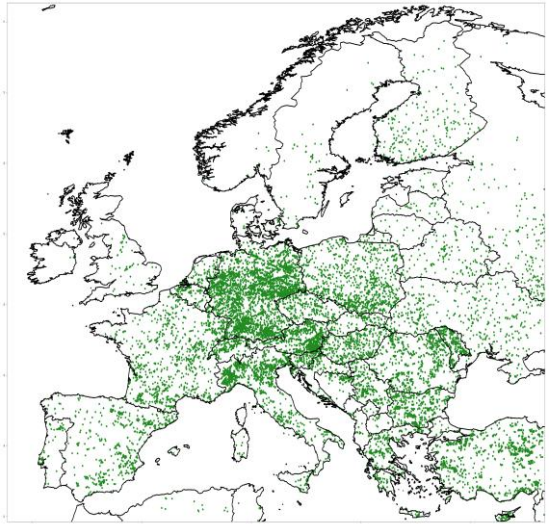
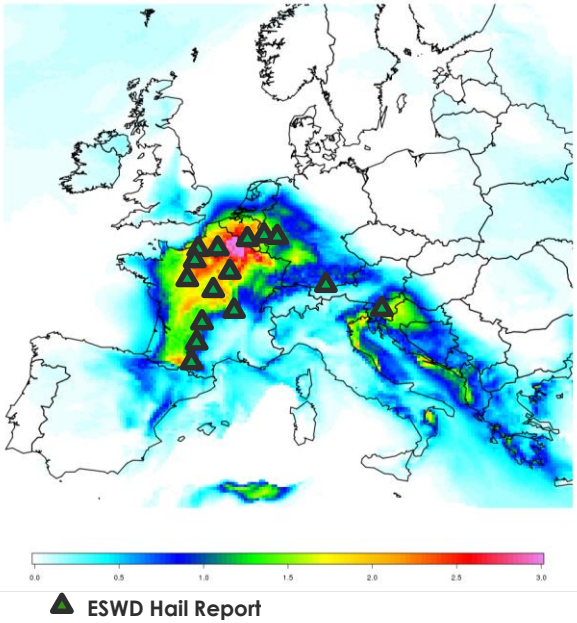
Scale of Severe Thunderstorms Requires a Multi-Faceted Approach

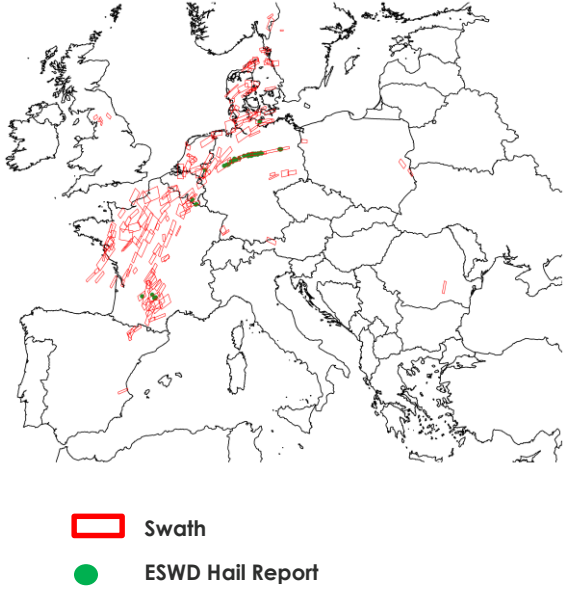
Storm Reports
(European Severe Weather Database)



Atmospheric Conditions
(ERA-Interim)



Radar Identified Hail Swaths
(OPERA)



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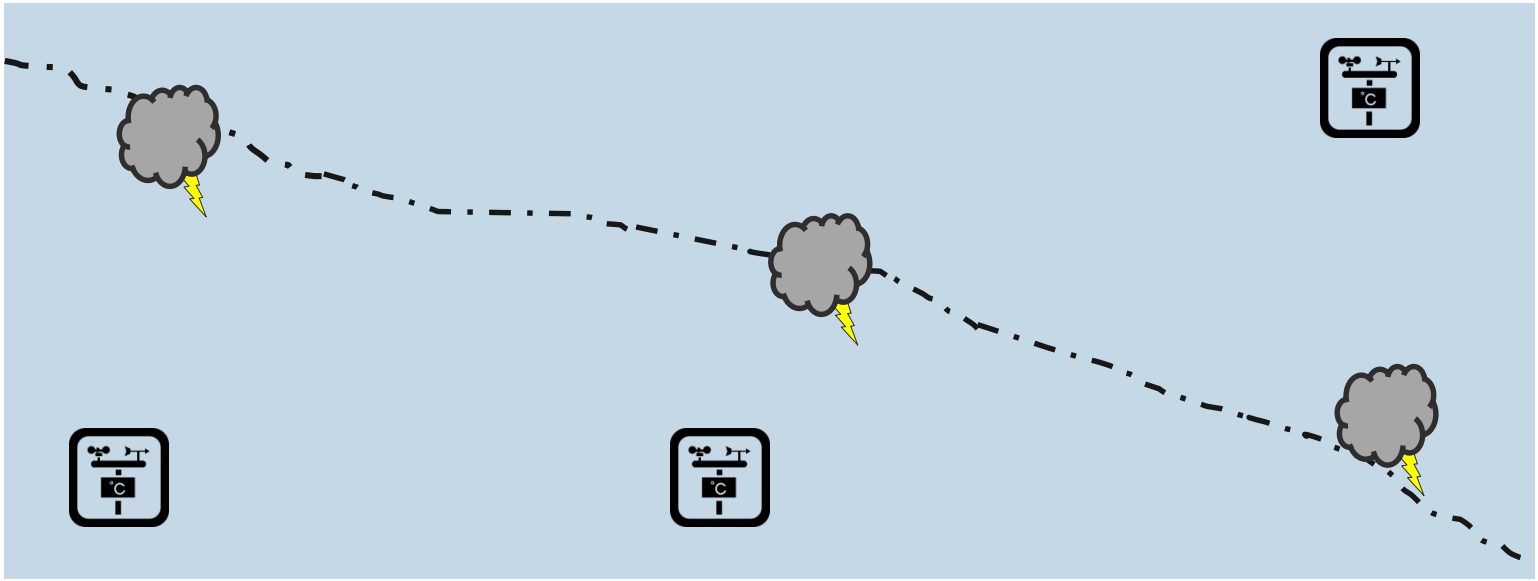
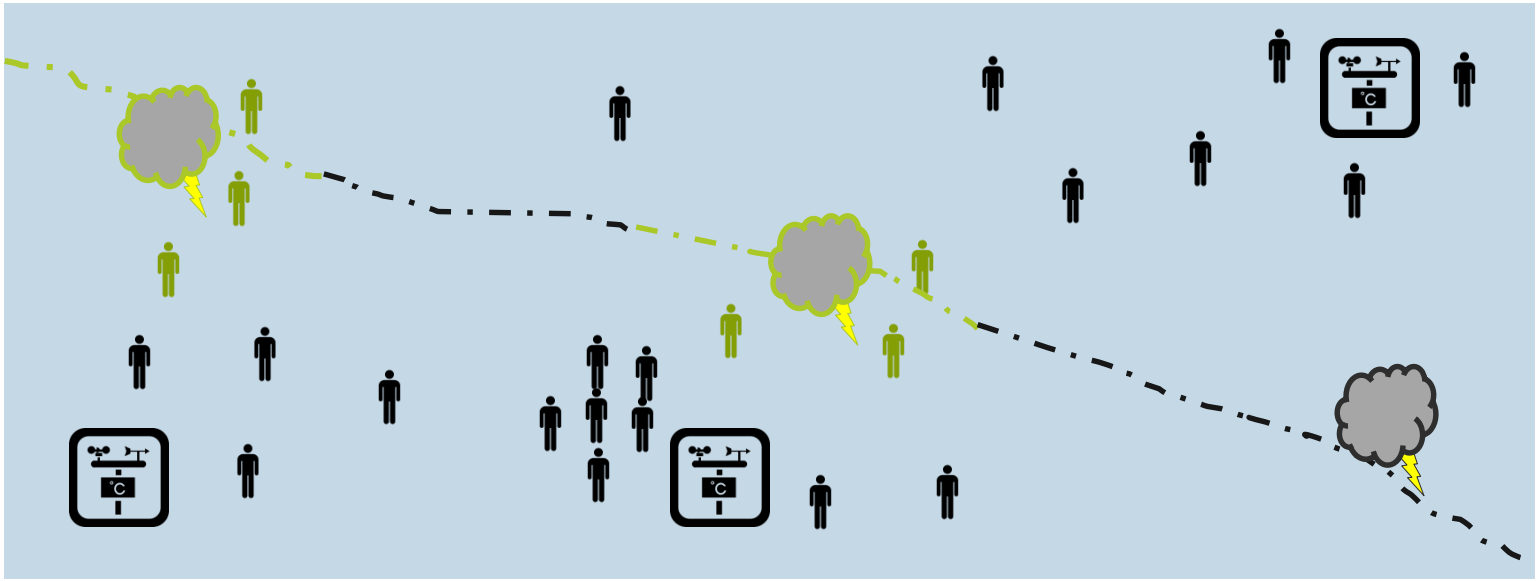
Scale of Storms Makes Them Difficult to Observe



Thunderstorm Weather station

Storm Reports Are a Local Crowdsourced Dataset

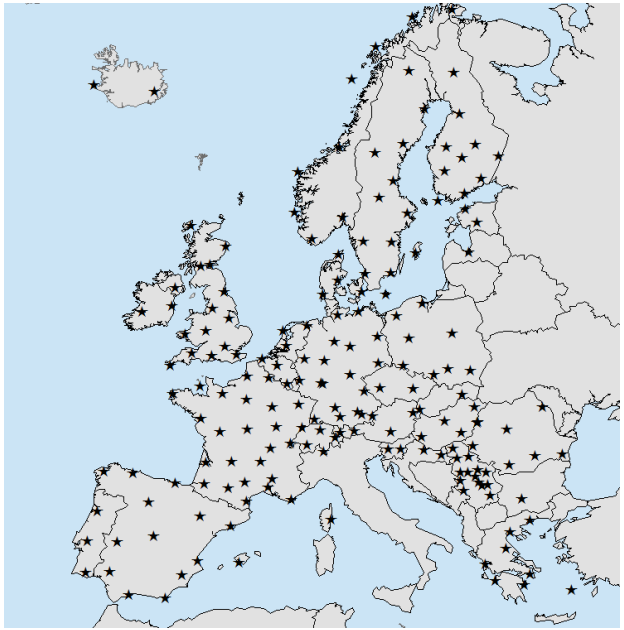


Radar Data Availability

OPERA

- Pan-European composite reflectivity mosaic
- 2-km grid
- 15-minute intervals
- Going back to 2011

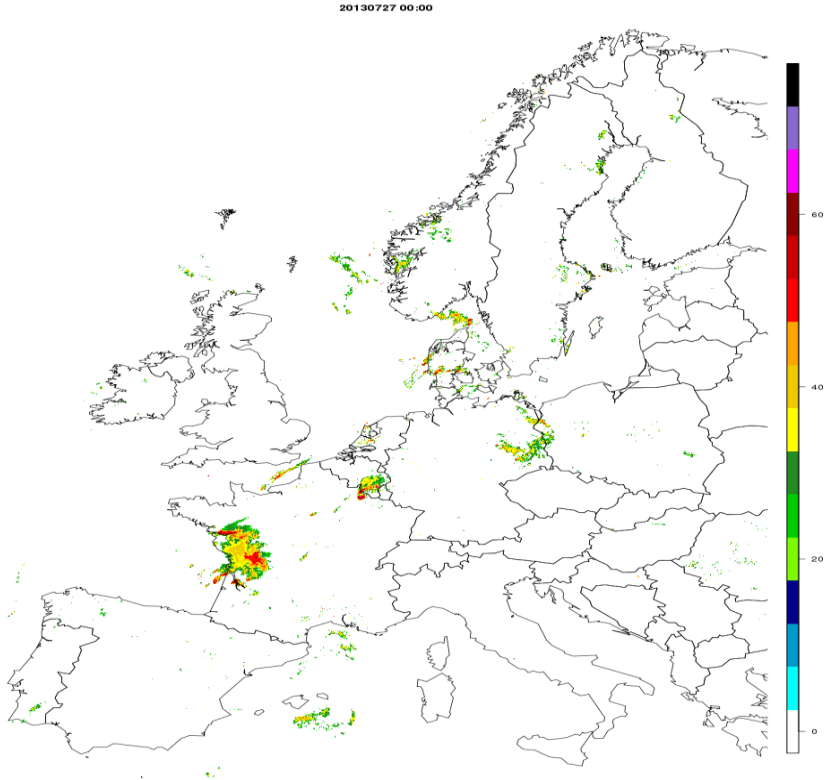
EUMETNET OPERA Radar Network



★ Radar Site

Radar Data Provides a More Complete Picture of Historical Events

Storm Andreas 2013



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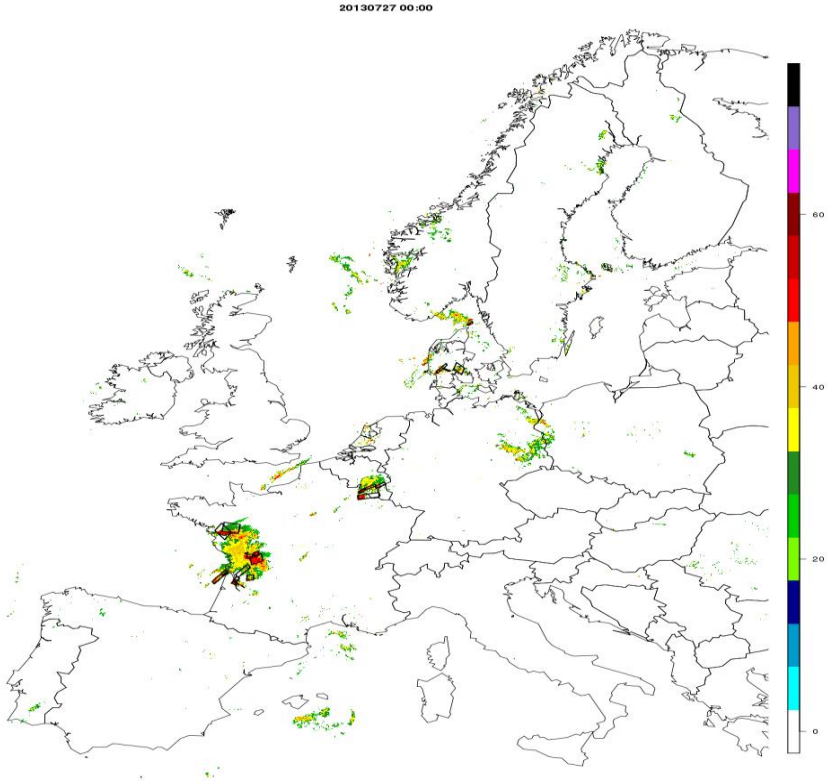

Algorithm tracks potentially severe storms in time and space

Storm footprint

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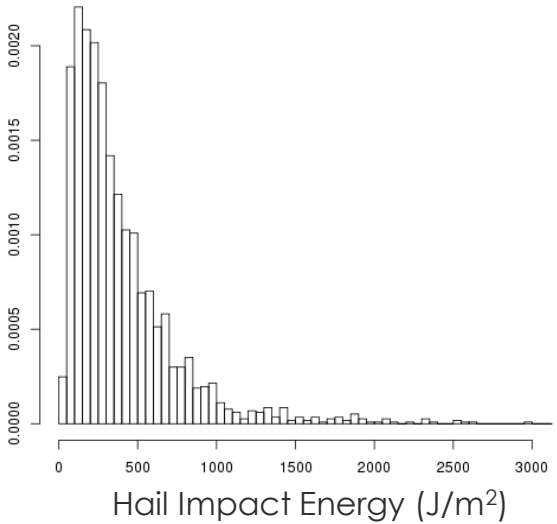
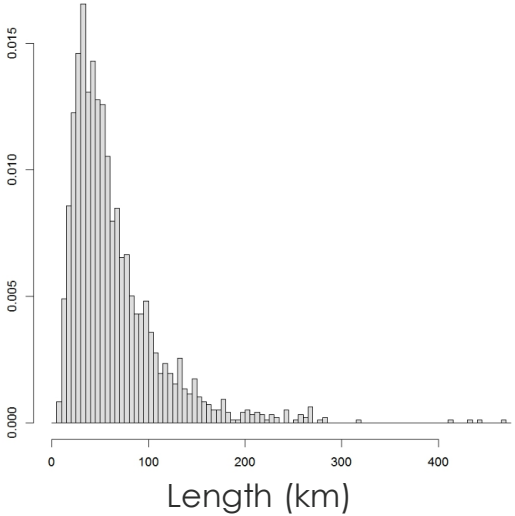
Repeating the Process over Many Days Gives Us Distributions for Length, Width, Intensity …

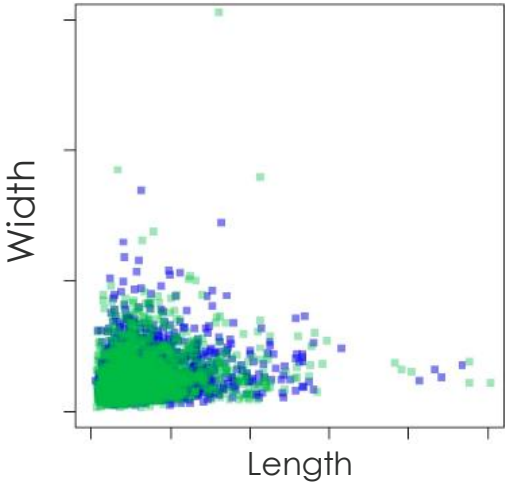
Intensity



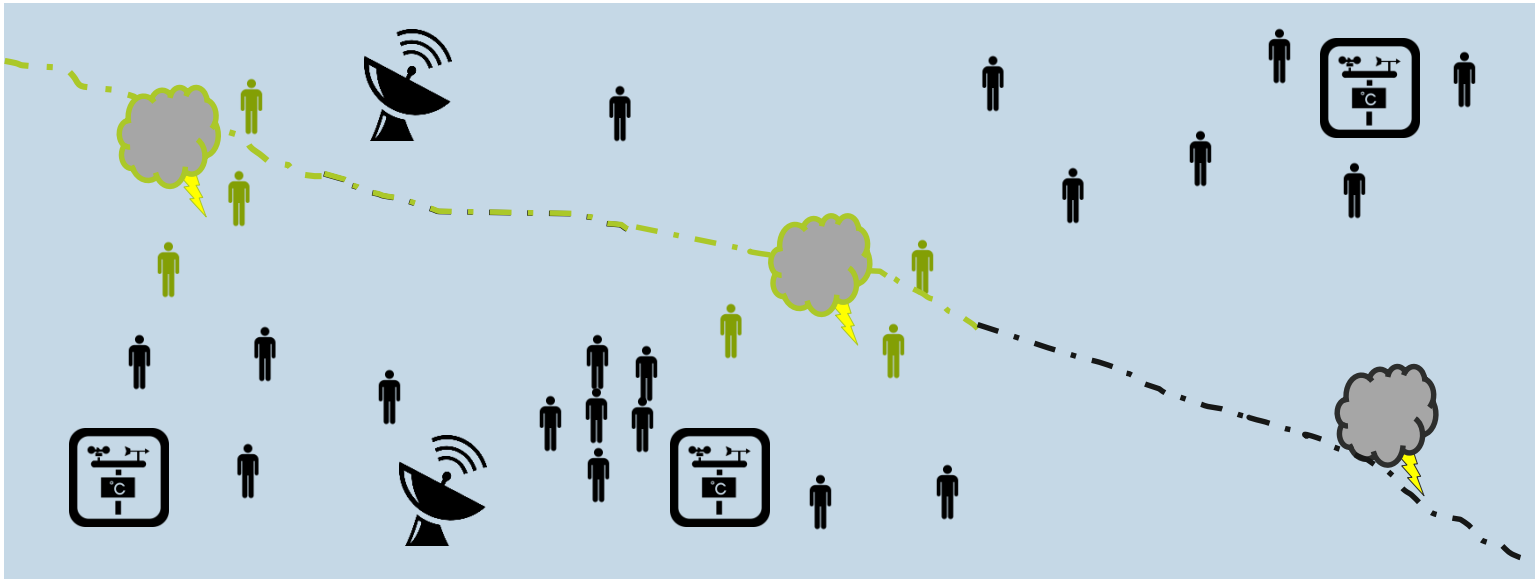
Length



Correlation

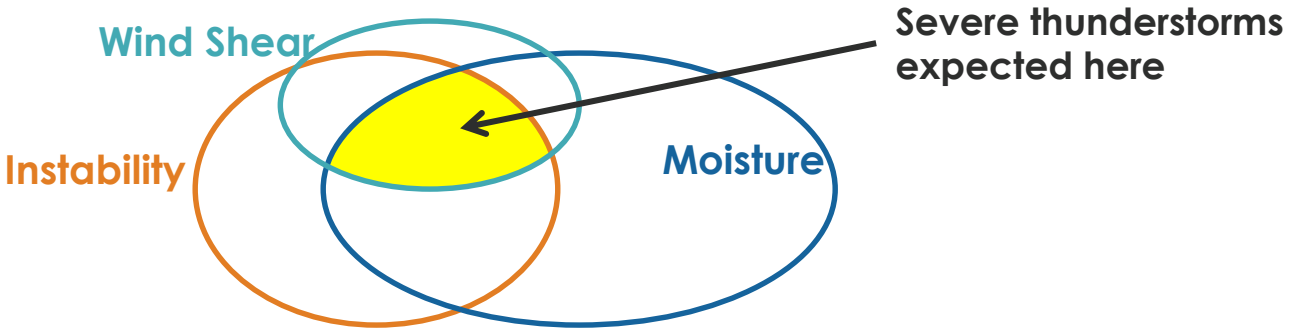


Radar Data Supplements Crowdsourced Reports

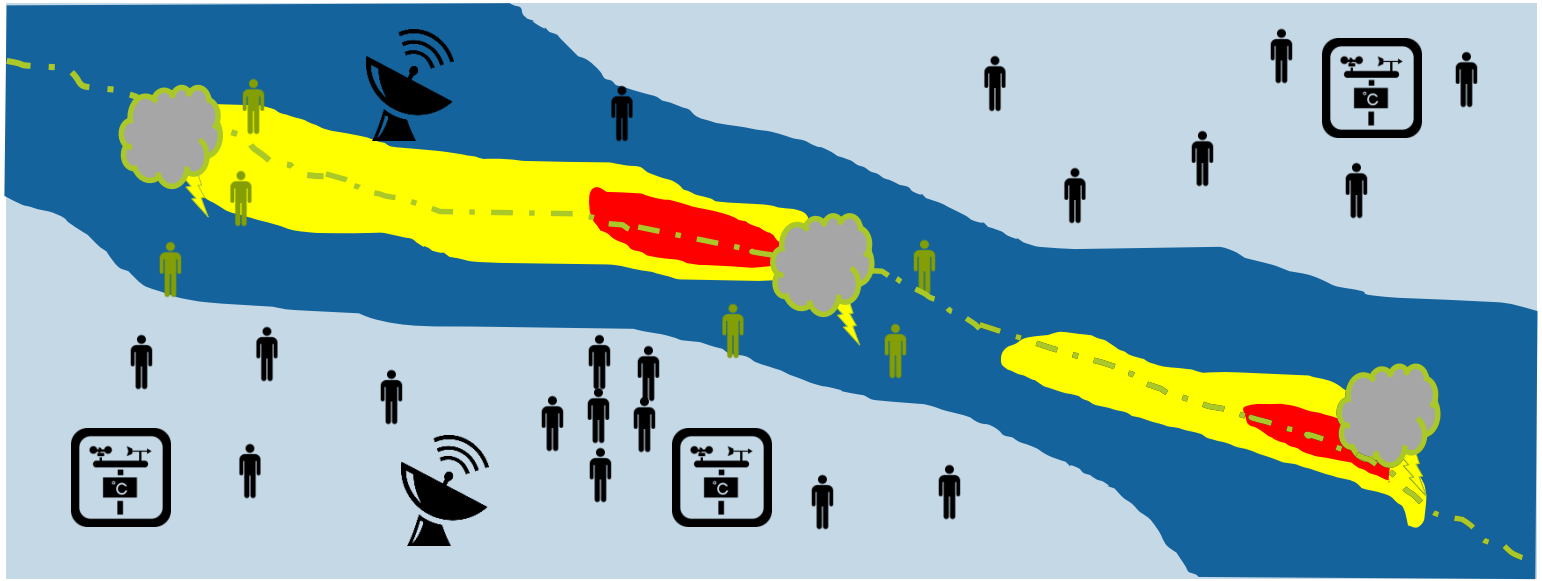


Atmospheric Reanalysis Helps Fill in Gaps

- ERA-Interim
  - Global, retrospective, and gridded; the best estimate of the atmosphere
- Composite severe thunderstorm indexes
  - Combine atmospheric conditions into a single parameter
  - Correlate with local severe thunderstorm activity



Reanalysis Completes the Picture

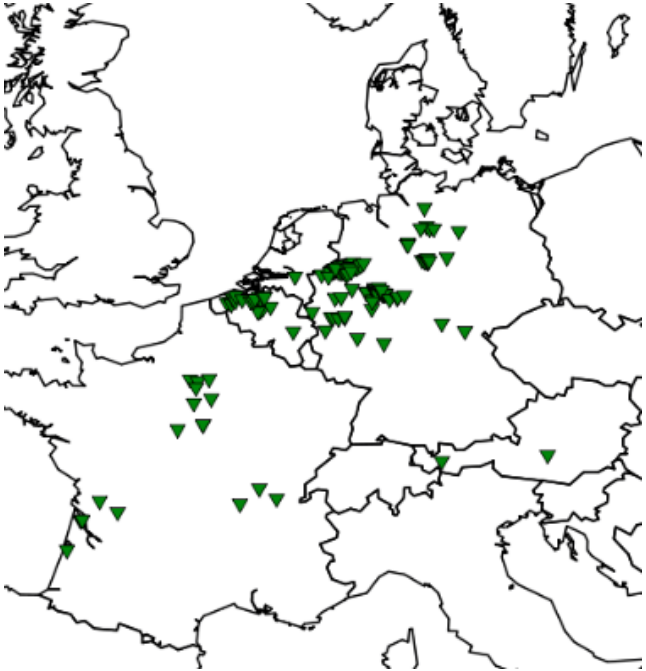


Radar Thunderstorm Weather station Observer Reanalysis

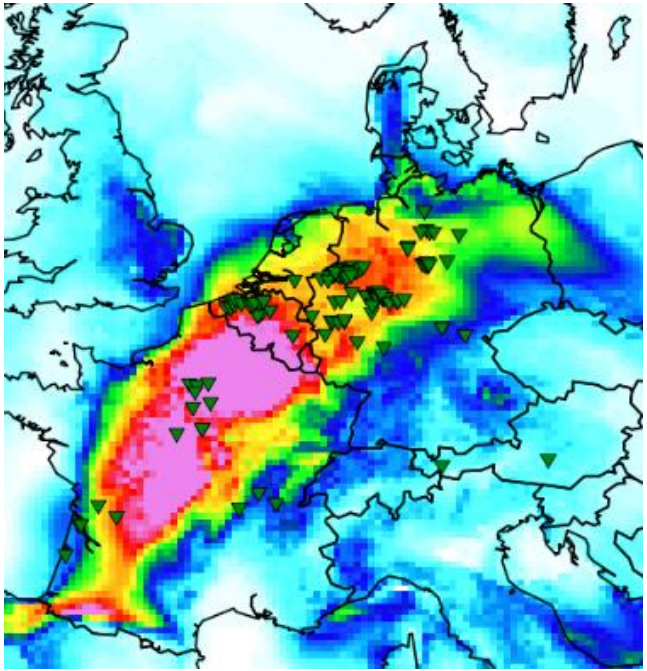
Reanalysis Completes the Picture

A Real-World Example: Ela 2014

Storm Reports



Atmospheric Conditions



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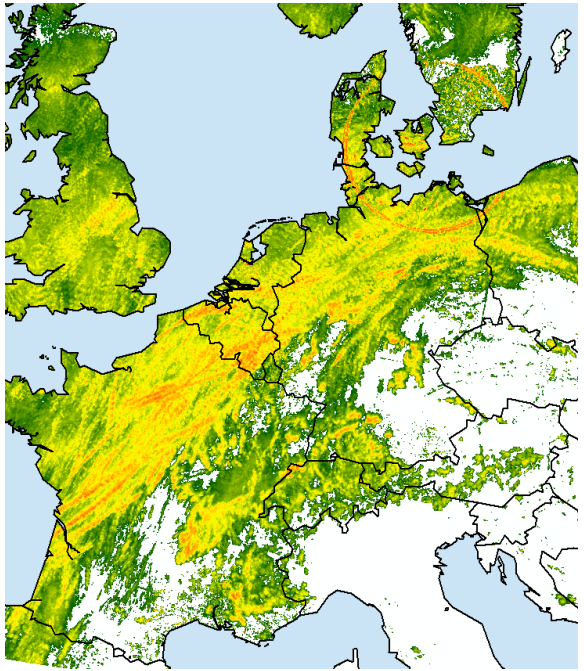
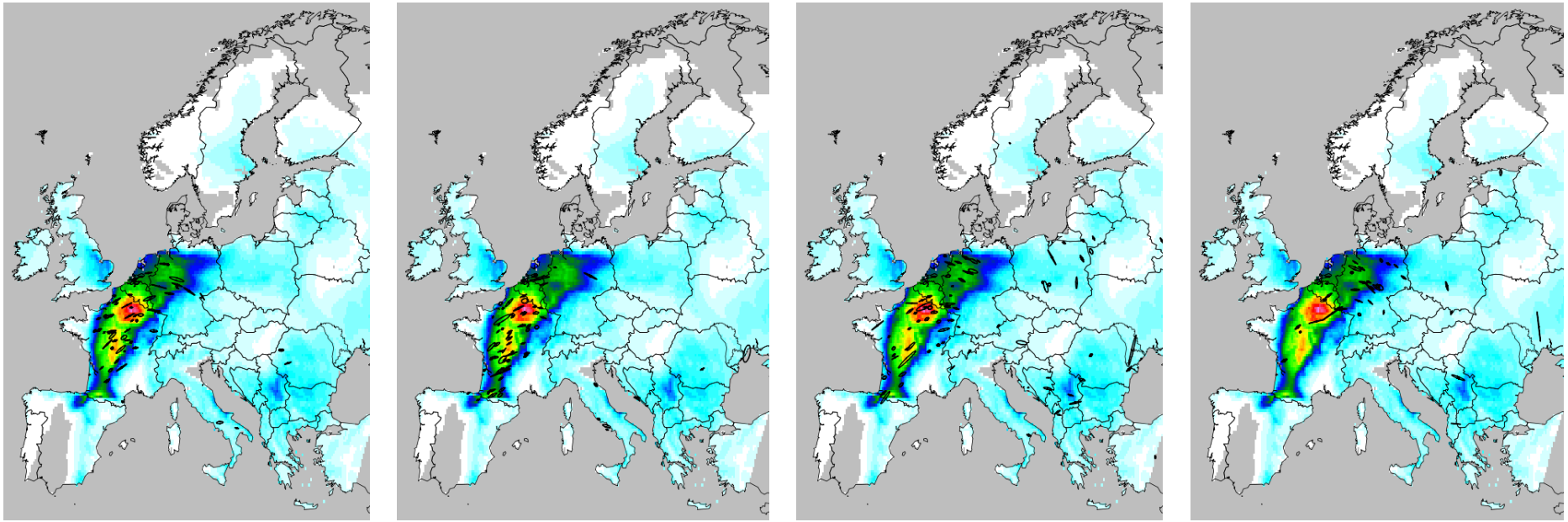


Stochastic Model Captures Variability

Multiple Simulations of Ela



Hail Probability

Low **High**

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Modeled View of Severe Thunderstorm Hazard

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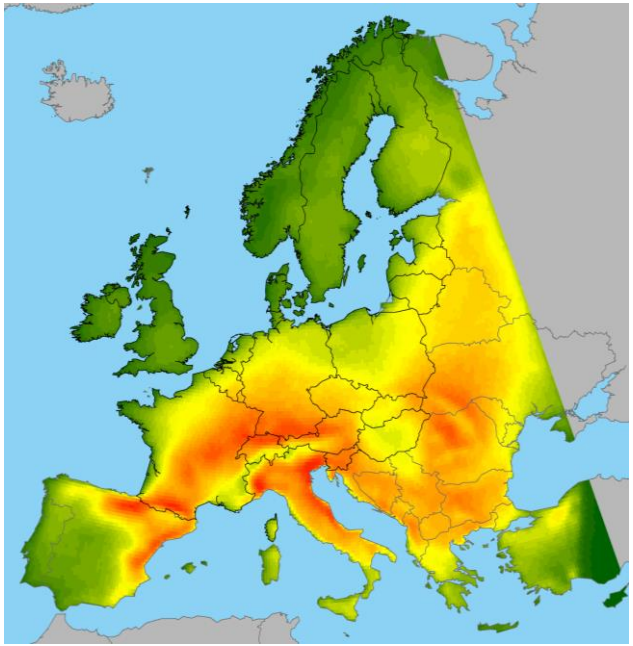
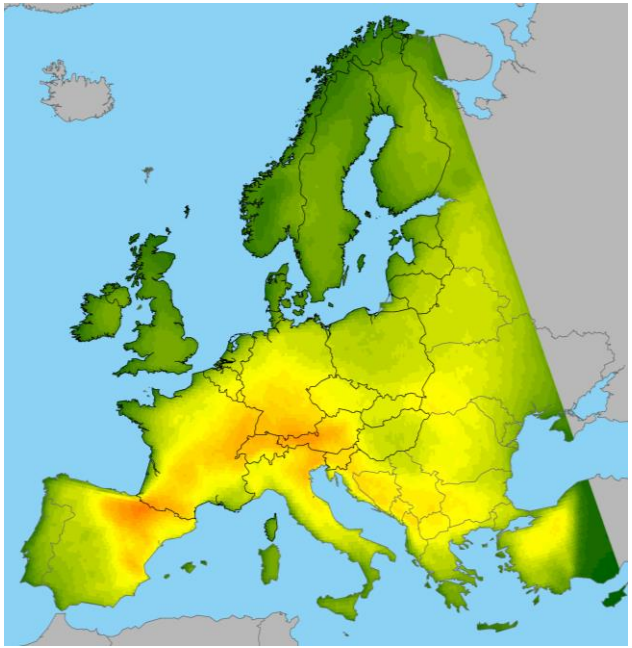
Simulated Hail and Wind Occurrence

Average Annual Hail Days



Average Annual Wind Days



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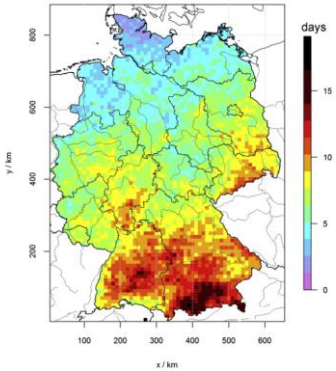
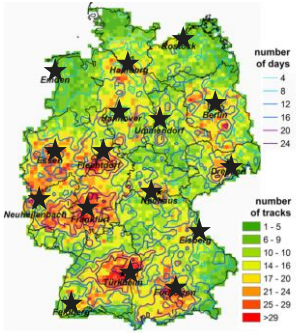
Simulated Hail Occurrence: Germany

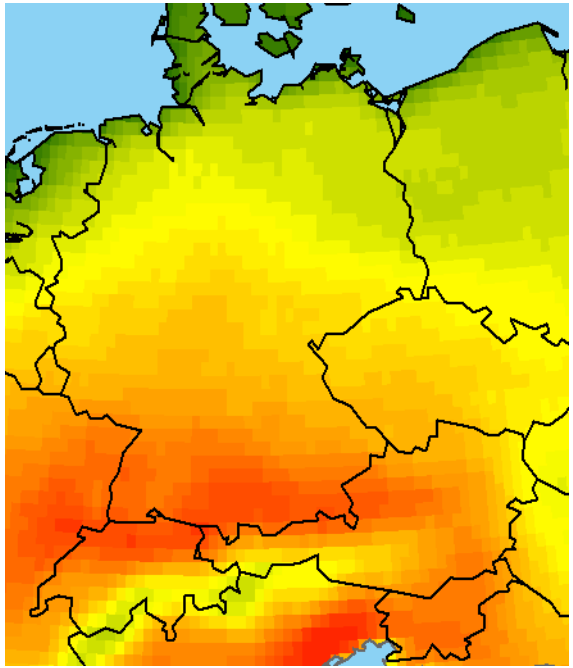
Thunderstorm Days from Lightning (Puskeiler et al. 2016)



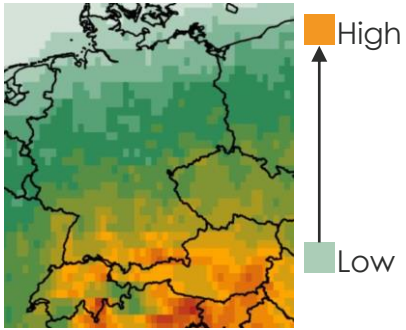
Radar-Derived Hail Occurrence (Puskeiler et al. 2016)



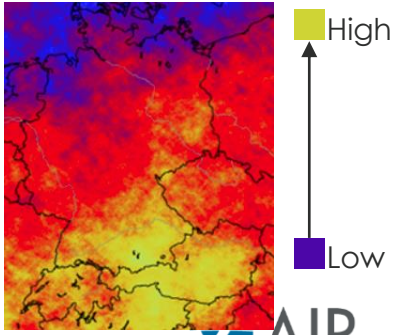
Simulated Hail Frequency



Lightning-Derived Hail Occurrence (Koumoutsaris et al. 2017)

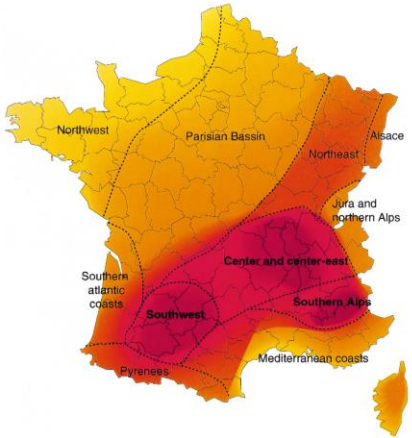


Overshooting Tops-Based Hail Occurrence (Punge et al. 2014)



Simulated Hail Occurrence: France

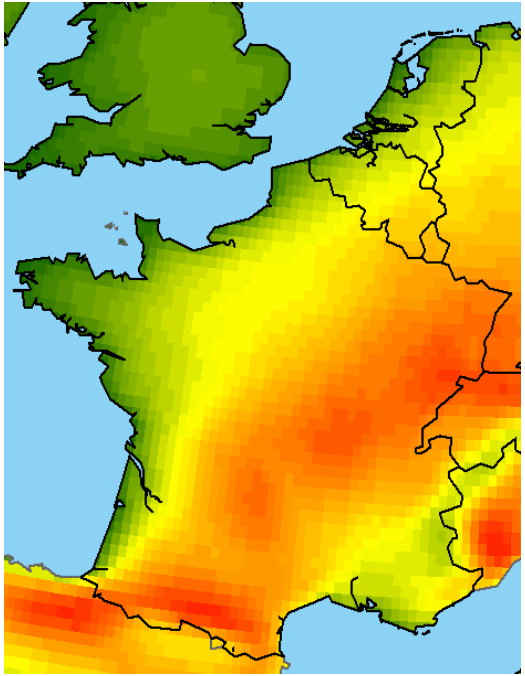
Hail Pad Hail Occurrence (Vinet 2001)



High

Low

Simulated Hail Frequency



High

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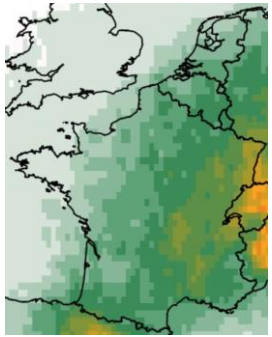
Lightning-Derived Hail Occurrence (Koumoutsaris et al. 2017)



High

Low

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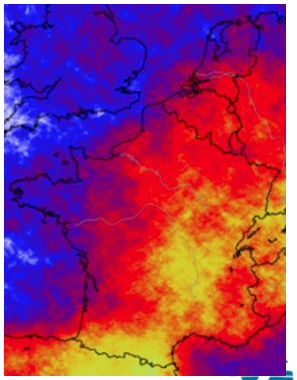

High

Low

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Vulnerability Component

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Salient Features of the Vulnerability Module

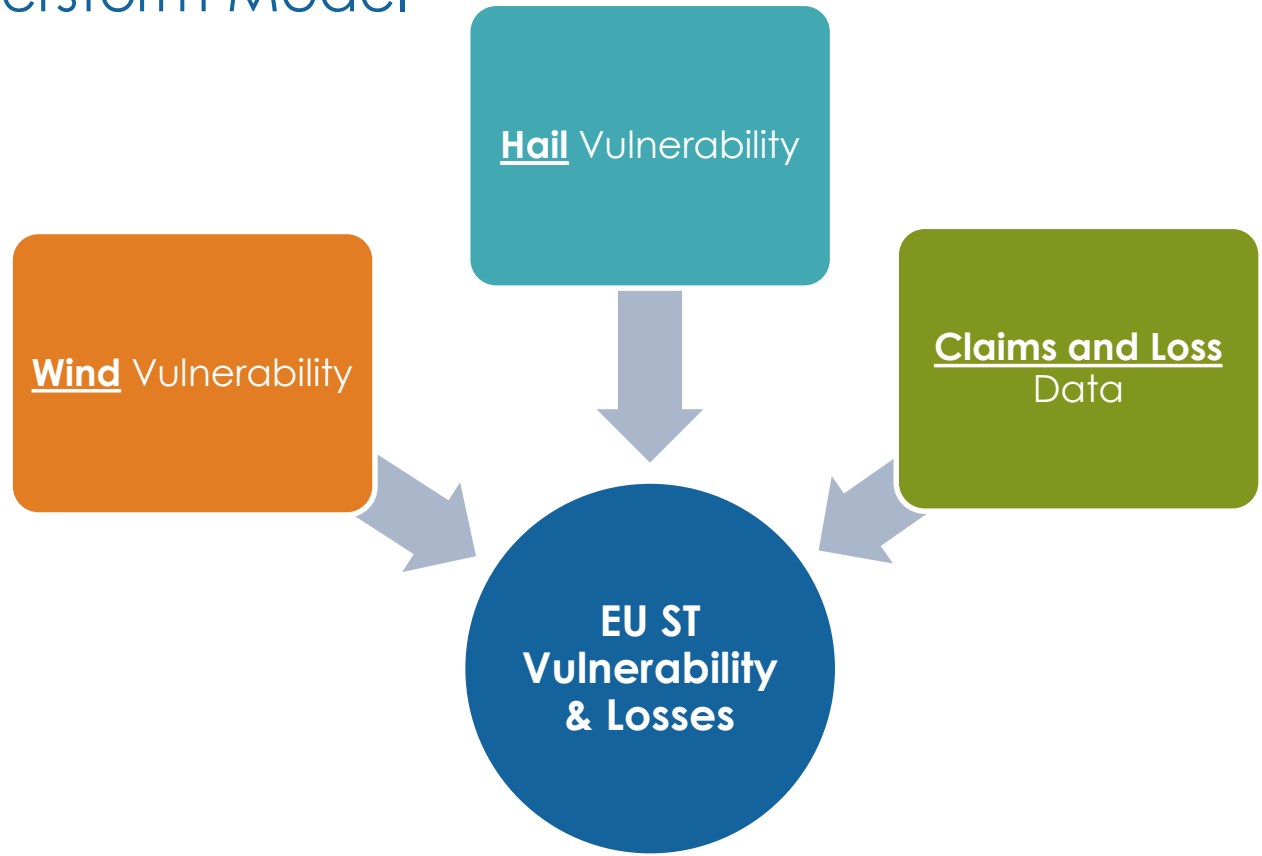
Supported Lines of Business

- Residential
- Commercial
- Small industrial
- Large industrial facilities
- Agricultural & greenhouses
- Automobiles and cars in dealerships & open lots
- Marine risks
- Wind turbines
- Forestry

Risk Differentiation

- Occupancy
- Construction
- Building height
- Regional variation
- Temporal variation
- "Unknown" damage functions account for regional building stock
- Peril-specific damage functions and damage distributions

Pillars of Vulnerability Module for the European Severe Thunderstorm Model



Typical Damage from Wind in Europe

Low Severity in Residential and Commercial Construction

- Moderate damage to roofs
- Large storefront windows damaged from wind-borne debris

Higher Damage Levels in Small Industrial and Agricultural Buildings

- Susceptibility of large spans to wind uplift
- Unbraced gable-end failures
- Unreinforced masonry wall collapses

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Claims and Loss Data for Wind

Claims Data

- EUR 7 billion
- 16 events
- 14 countries
- 19 companies

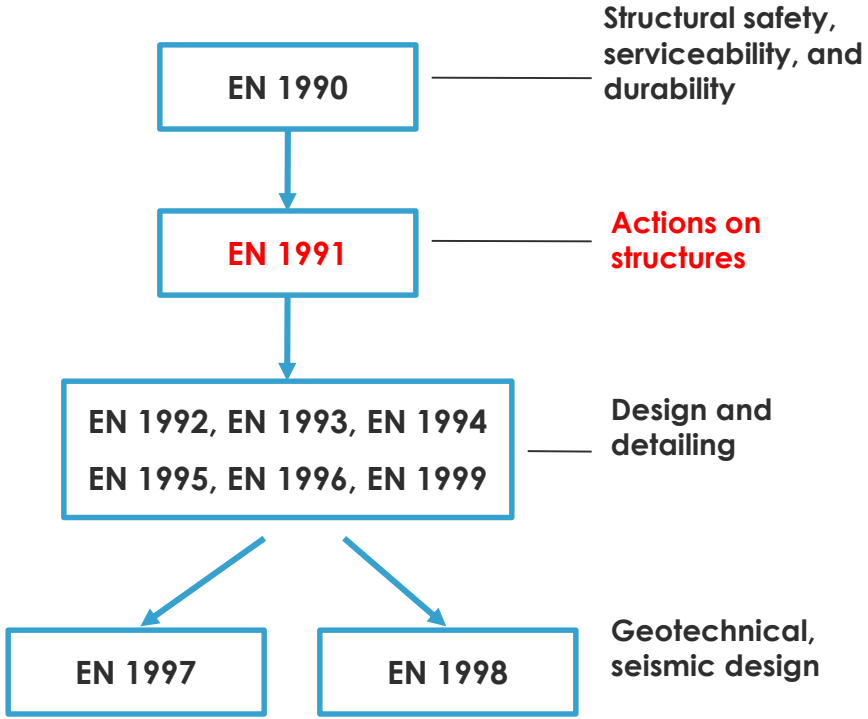
Insurance Associations

- German Insurance Association
- French Insurance Federation
- Austrian Insurance Company Association
- Switzerland, Association of Cantonal Building Insurance

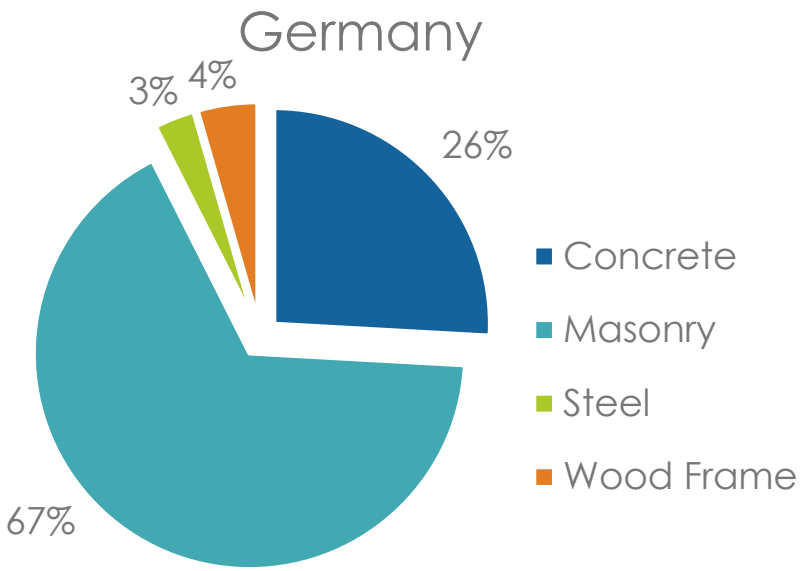
PERILS

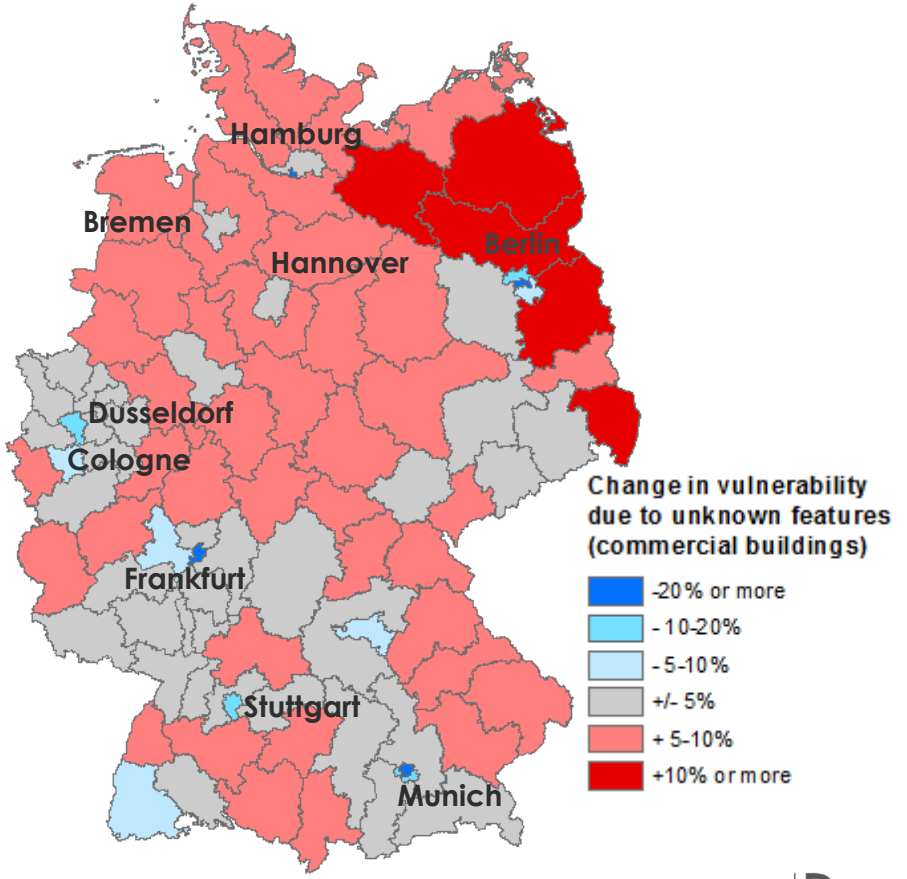
- EUR 22 billion
- 17 events
- 12 counties

Accounting for Regional Variation in Wind Vulnerability

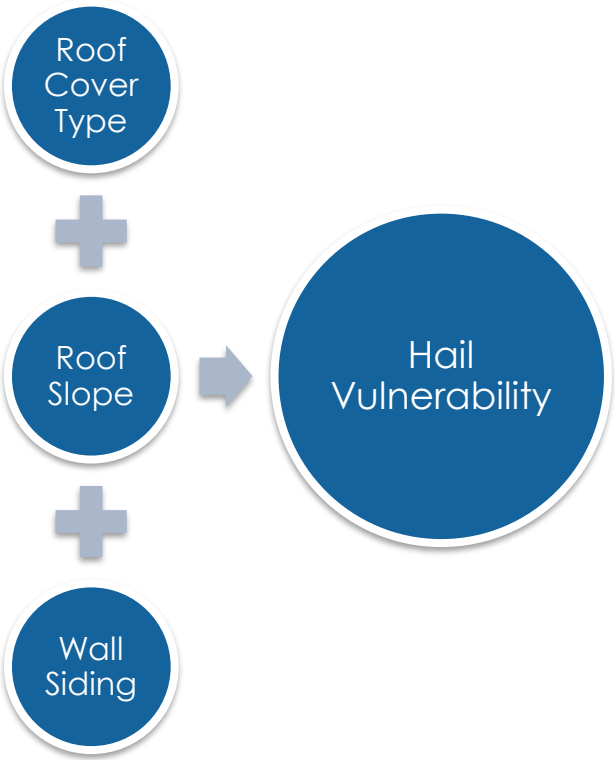


Vulnerability Is Differentiated Based on Regional Building Stock





Hail Vulnerability of the European Building Stock



Characteristics of European buildings from a hail vulnerability perspective

Vulnerability of different building components to hail

Characteristics of European Buildings from a Hail Vulnerability Perspective

Ceramic Tile

Concrete Tile

Gravel

Bitumen Layer

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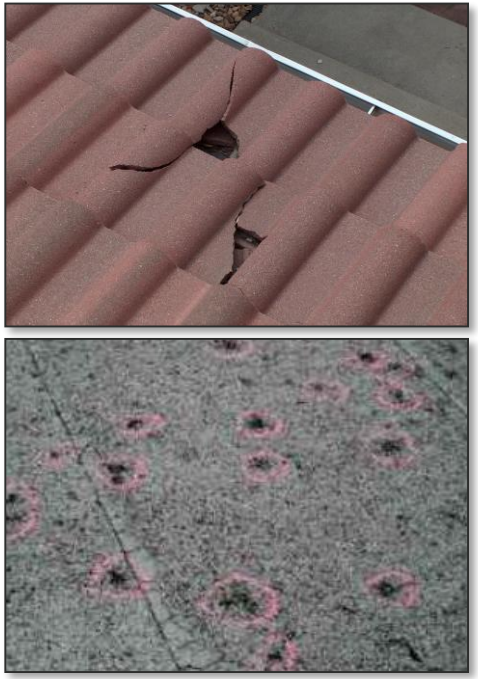
Findings from Hail Experiments, Damage Surveys, and Claims Studies Inform Hail Vulnerability

Experiments

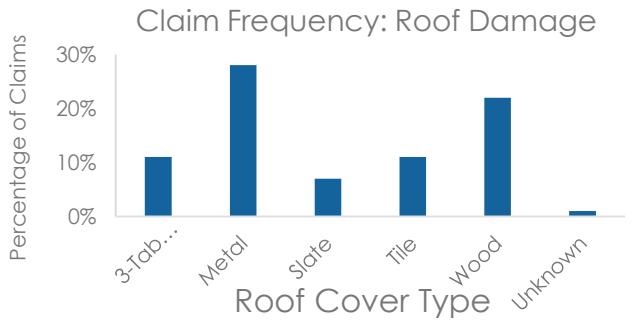
Source: Marshall et al., 2002

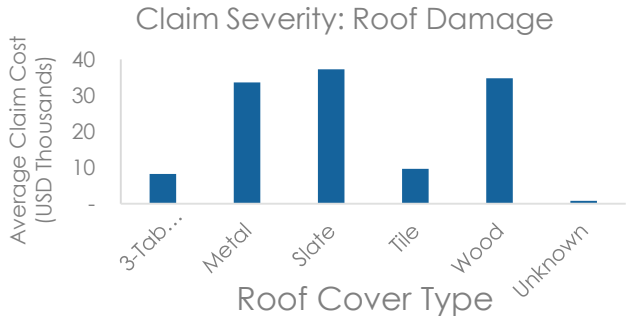
Damage Surveys



Source: RICOWI & AIR Damage Surveys

Claims Studies





Source: IBHS, 2013

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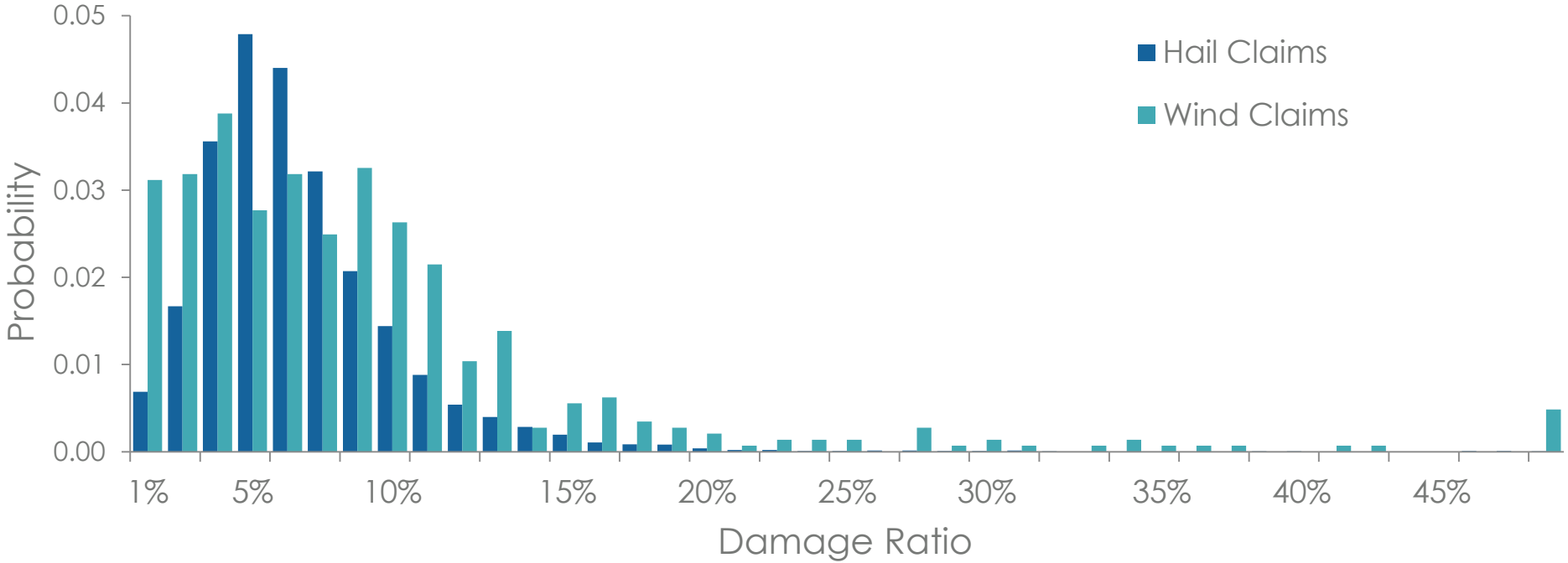
Sub-Peril–Specific Damage Distributions Account for Uncertainty in Local Hazard and Damage

Sample Damage Distributions from Hail and Wind Claims Data



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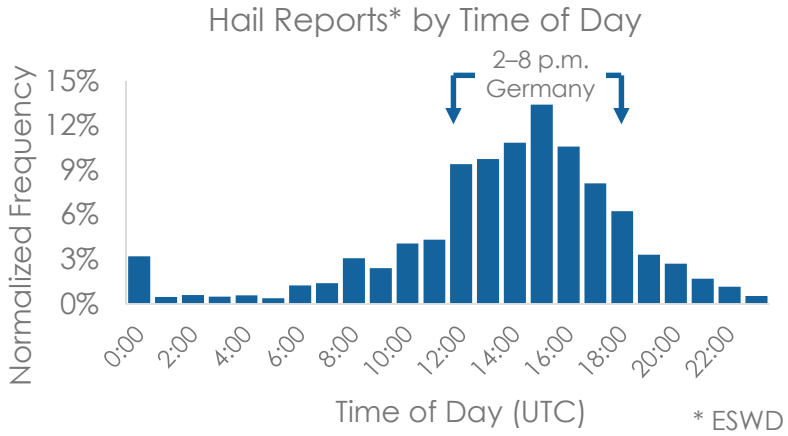
Automobiles: Personal

The hail damage function for automobiles implicitly reflects the fact that:

- Hailstorm occurrence varies by time of day
- Peak tends to occur during commuting hours, when the number of vehicles exposed is relatively high



Automobiles: Commercial

- Auto fleets can suffer significant hail losses due to large numbers of vehicles in the same location
- Model captures this increased hail vulnerability explicitly, with unique damage functions developed for accumulated risks

Huge Hail Storm Damages Up to 30,000 New Volkswagens

"Hail damage might cost Volkswagen's insurers hundreds of millions of euros."

(Source: Spiegel Online, 2008)

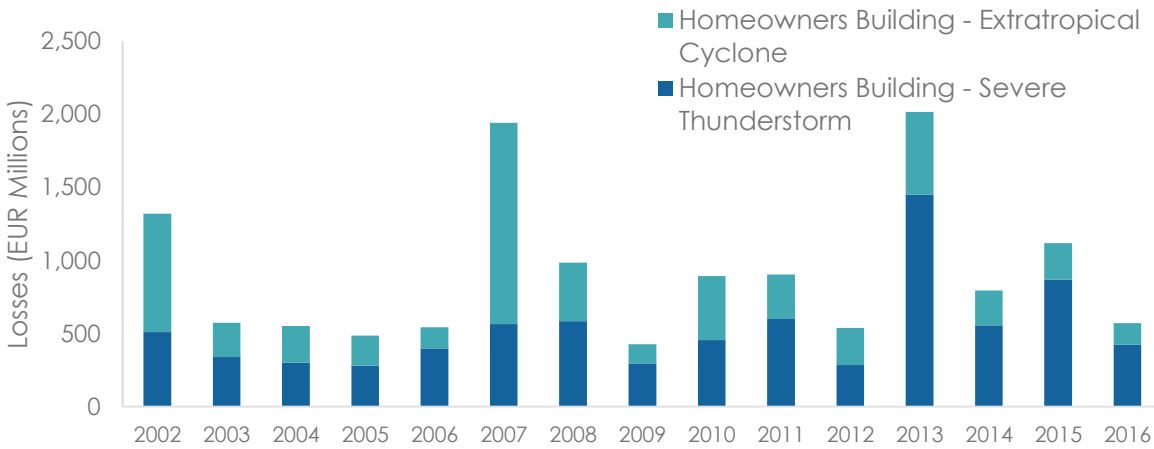
AIR Leveraged Multiple Sources of Loss and Claims Data Specific to Severe Thunderstorms

- Industry losses from multiple sources
- Insurance agency data
  - Annual losses by peril and line of business for several decades in Austria, France, Germany and Switzerland
  - Historical event loss benchmarks for the industry and select lines of business by peril along with loss footprints
- Company data: detailed by event, day, location

Data from Insurance Associations Is Leveraged in Model Validation

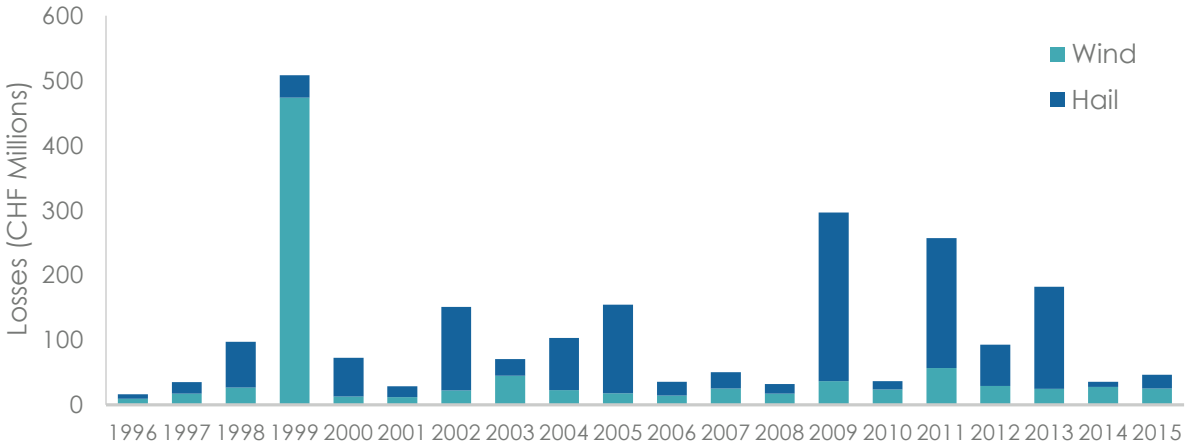
GDV
DIE DEUTSCHEN VERSICHERER

~EUR 9 Billion



VKG AECA

~EUR 2 Billion



Claims and Exposure Data for Model Calibration and Evaluation

- EUR 1 billion in claims, mostly from major events since 2010
- From five large insurance companies in Germany, France, and the Netherlands
- Exposure and claims data mostly at policy level
- Residential/non-residential split is about 60/40

Germany Hail Storm Andreas (July 2013)

(photo courtesy of Benjamin Wolf)

Modeled Losses

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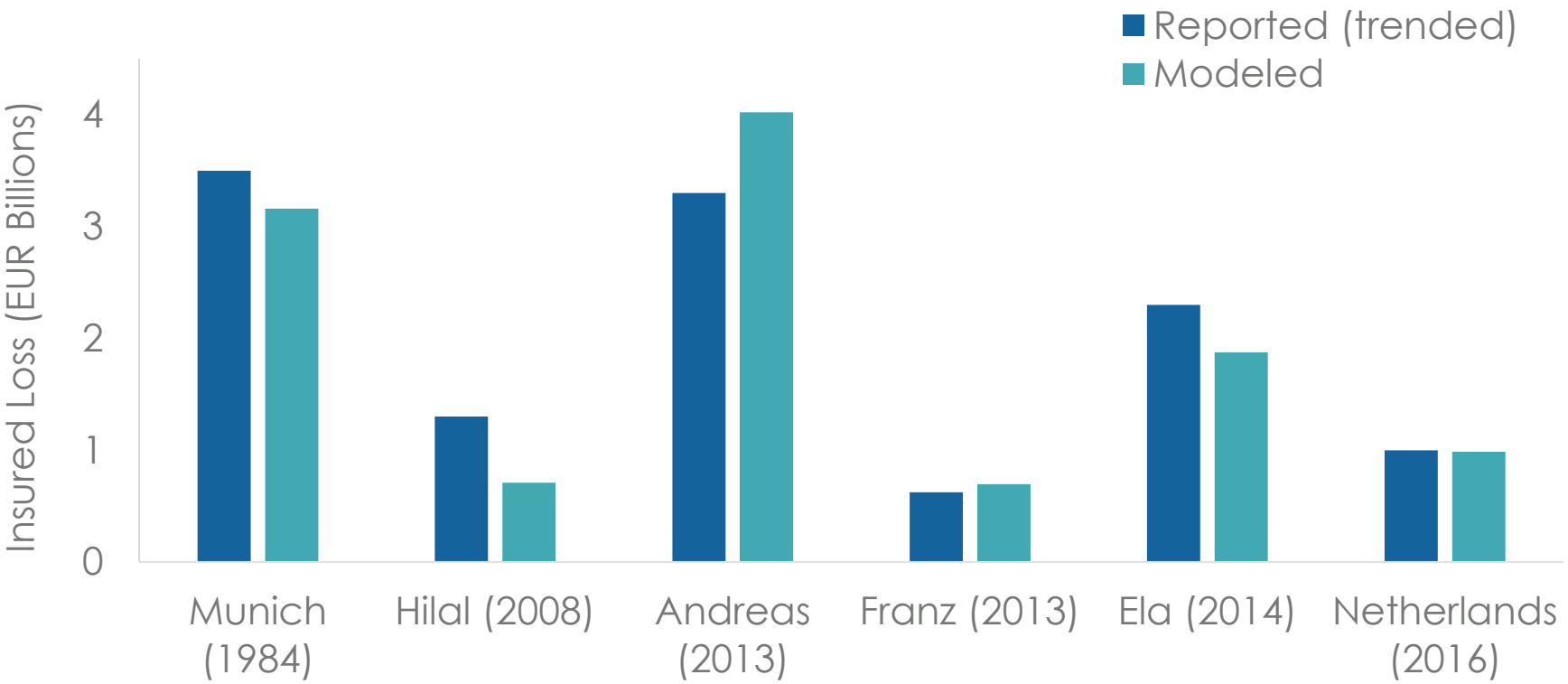
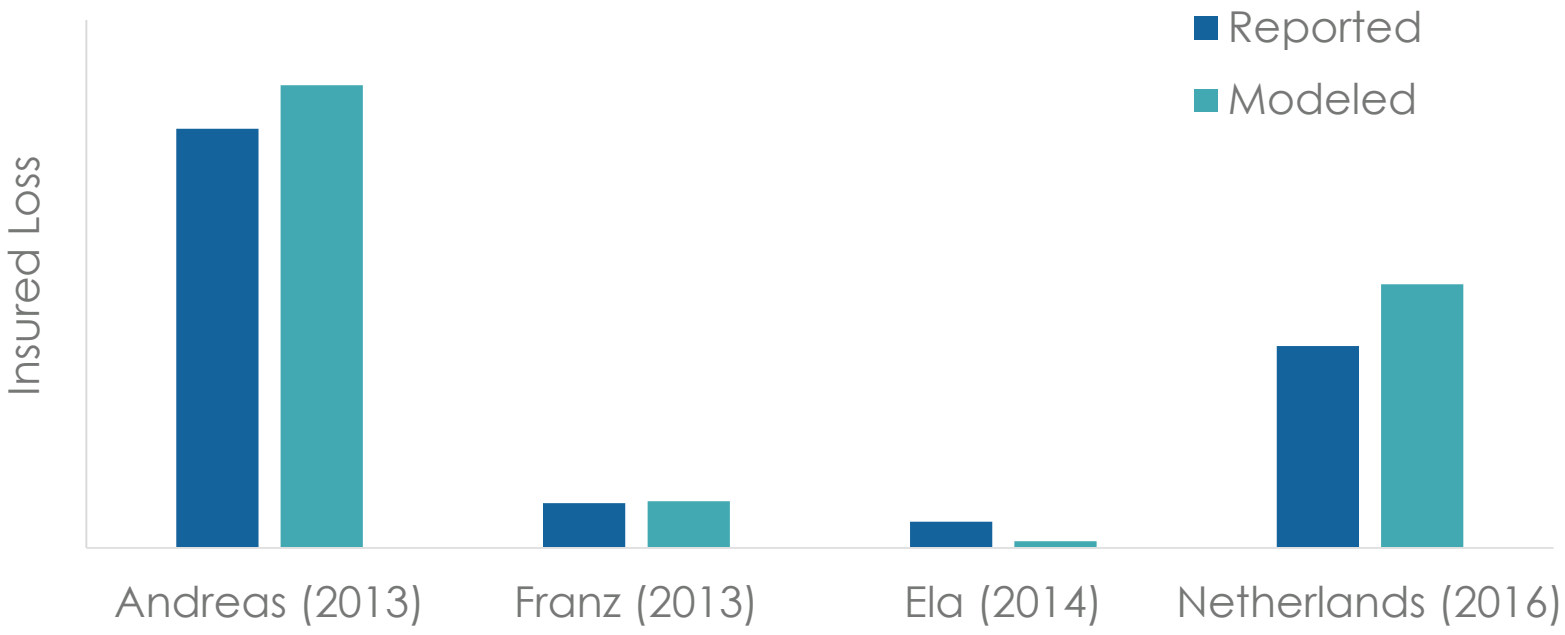
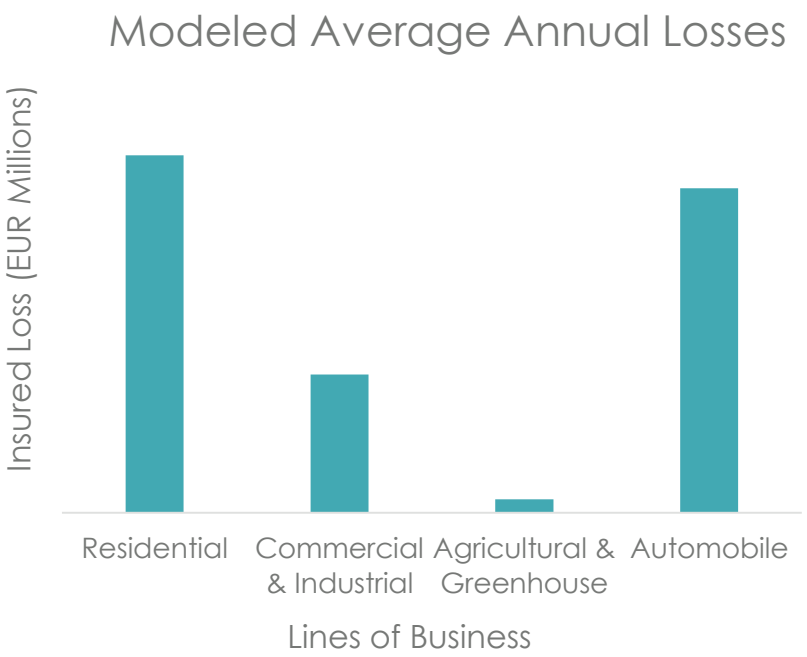
Historical Events Loss Evaluation: Industry Losses

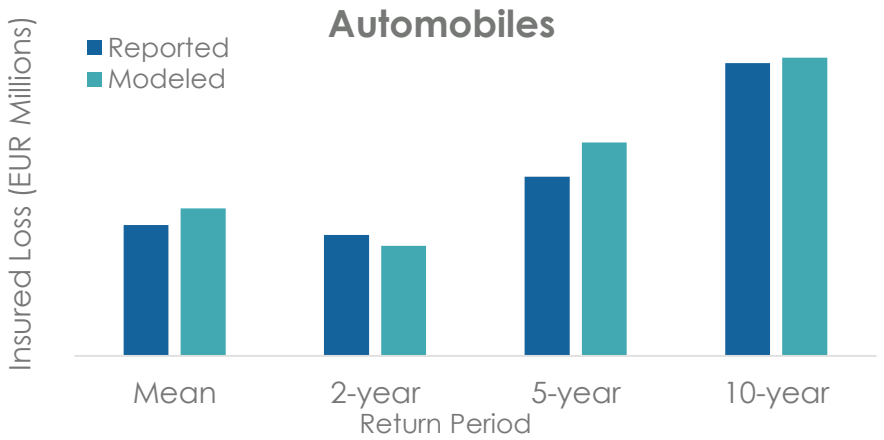


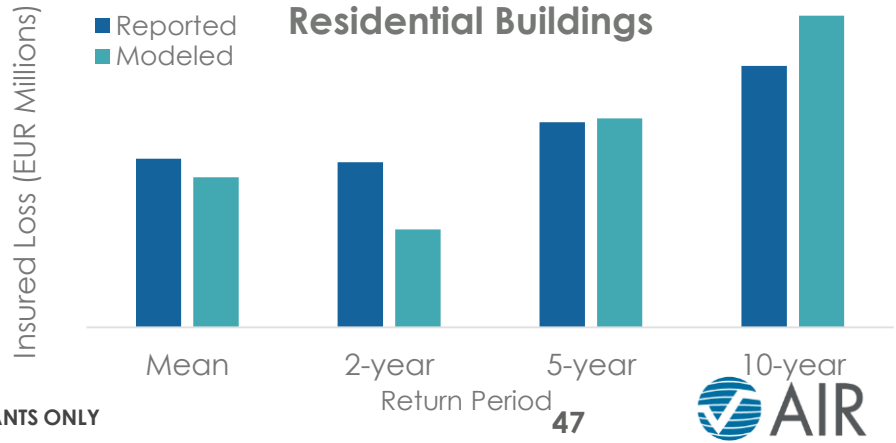
Historical Events Loss Evaluation: Company Losses



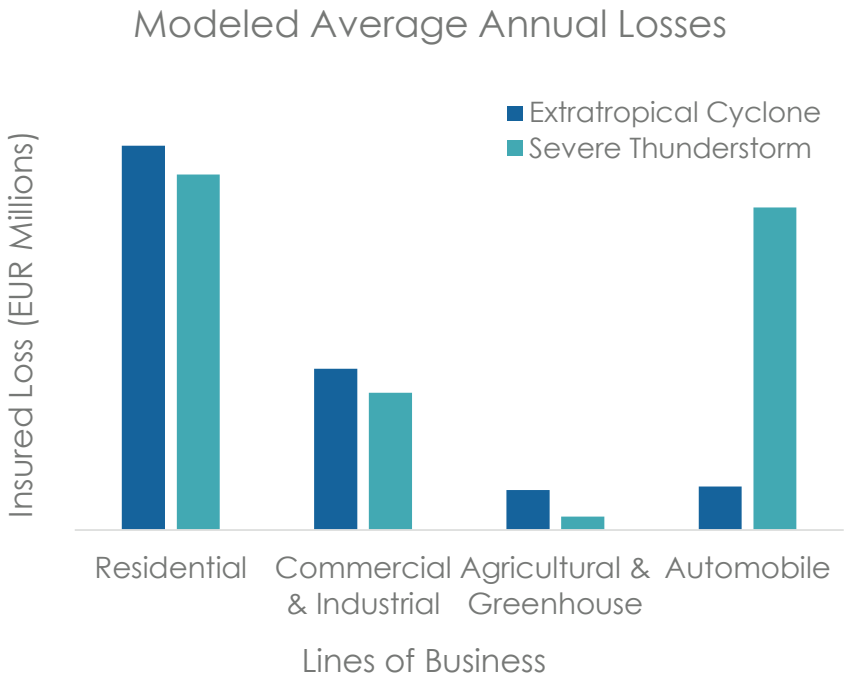
Stochastic Events Loss Evaluation: Germany



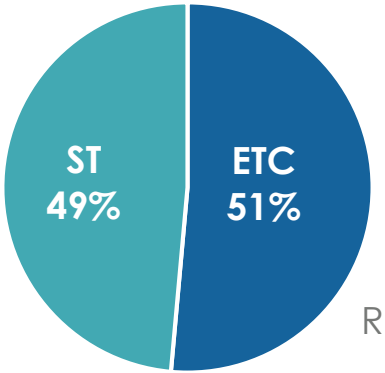




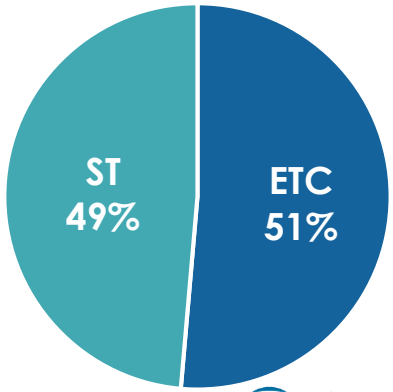
Stochastic Events Loss Evaluation: Germany



Residential: Modeled



Residential: Reported



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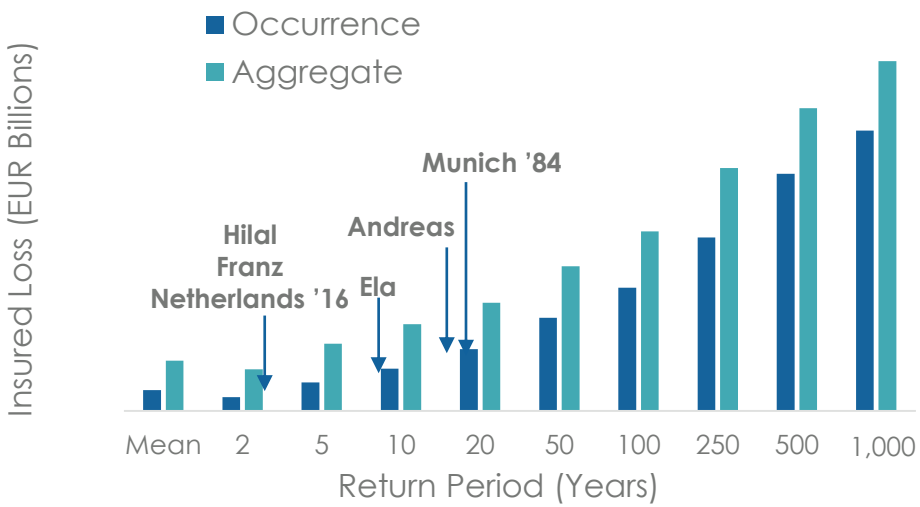
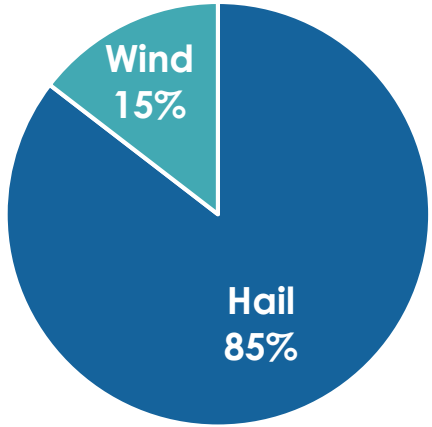
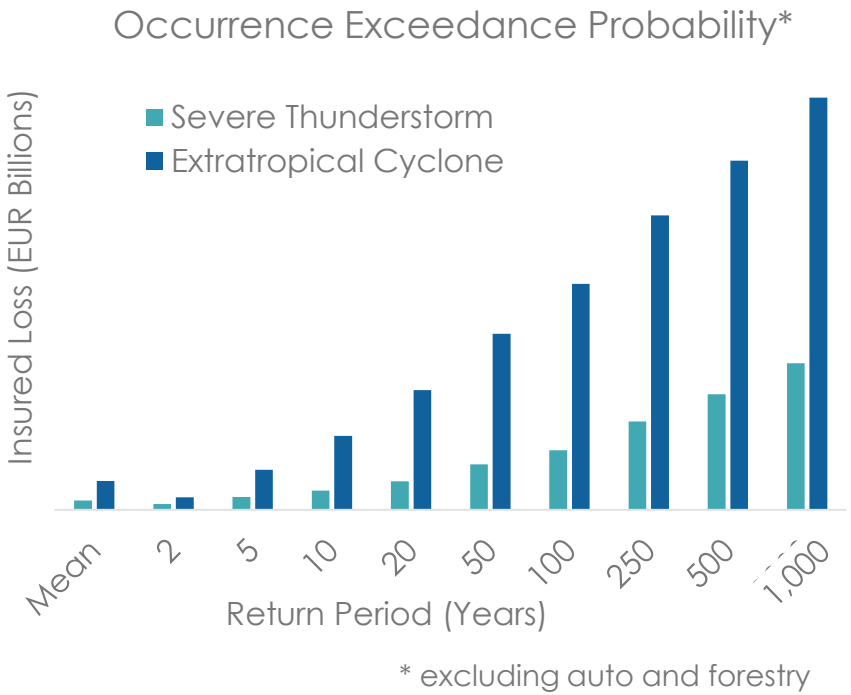
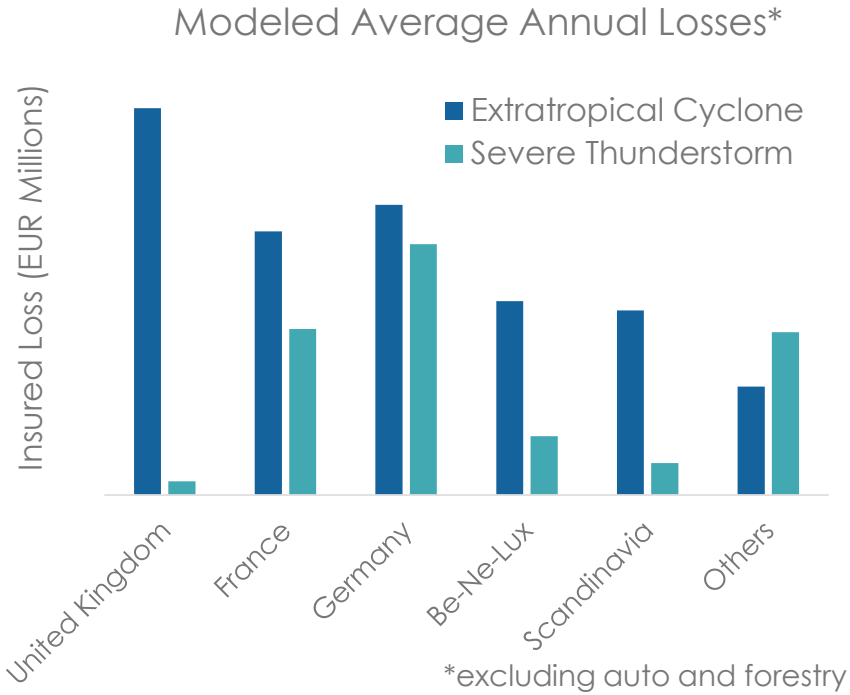
Exceedance Probability Loss Curves: Europe





Exceedance Probability Loss Curves: Europe





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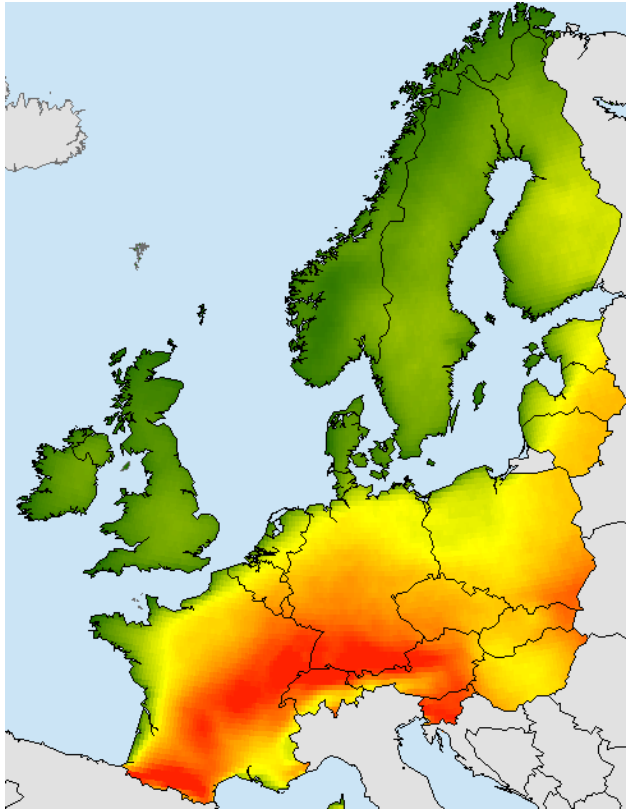
AIR Severe Thunderstorm Model for Europe

- Captures severe thunderstorm risk for 22 countries and many lines of business
- Quantifies risk through a unique variety of data sources
- Validated through extensive claims and loss data



6–7 September 2018

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Lisbon, Portugal

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