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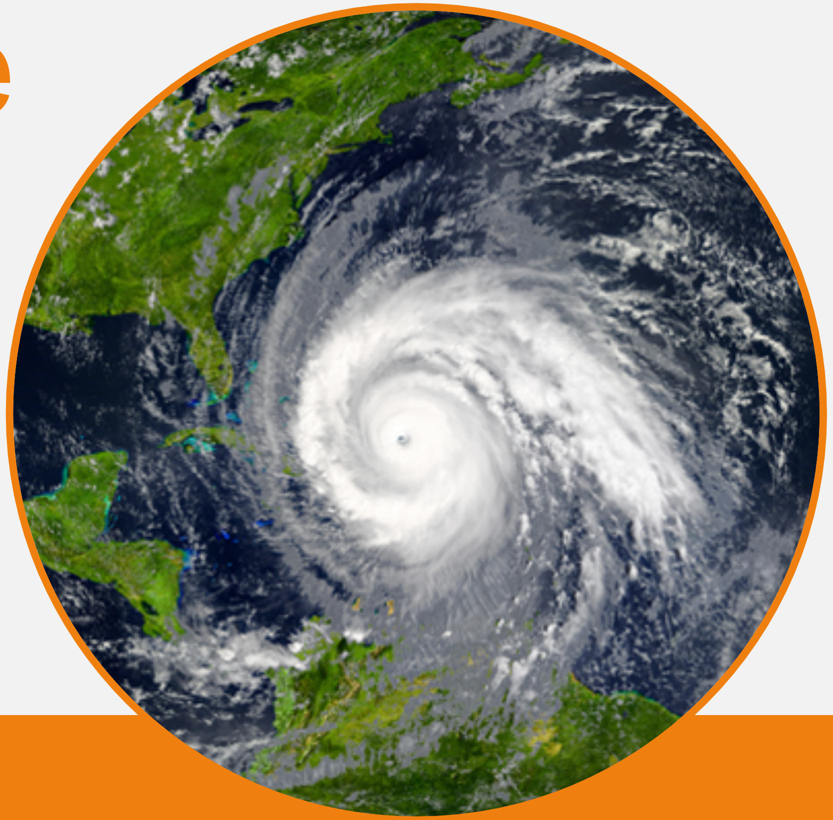
How well do catastrophe models represent the past, the present, and the future?



11 June 2020, 2pm BST

#ICMIFwebinar

How well do catastrophe models represent the past, the present, and the future?

Moderator: Mike Ashurst, Vice-President, Professional Development and Reinsurance, ICMIF

Tim Fewtrell

Executive Director, Head of Catastrophe Analytics EMEA N/E

Ditte Deschars

Regional Director, Head of Willis Re Nordic

WillisRe

How well do catastrophe models represent the past, the present, and the future?

MORO Webinar Series

icmif

June 12th 2020

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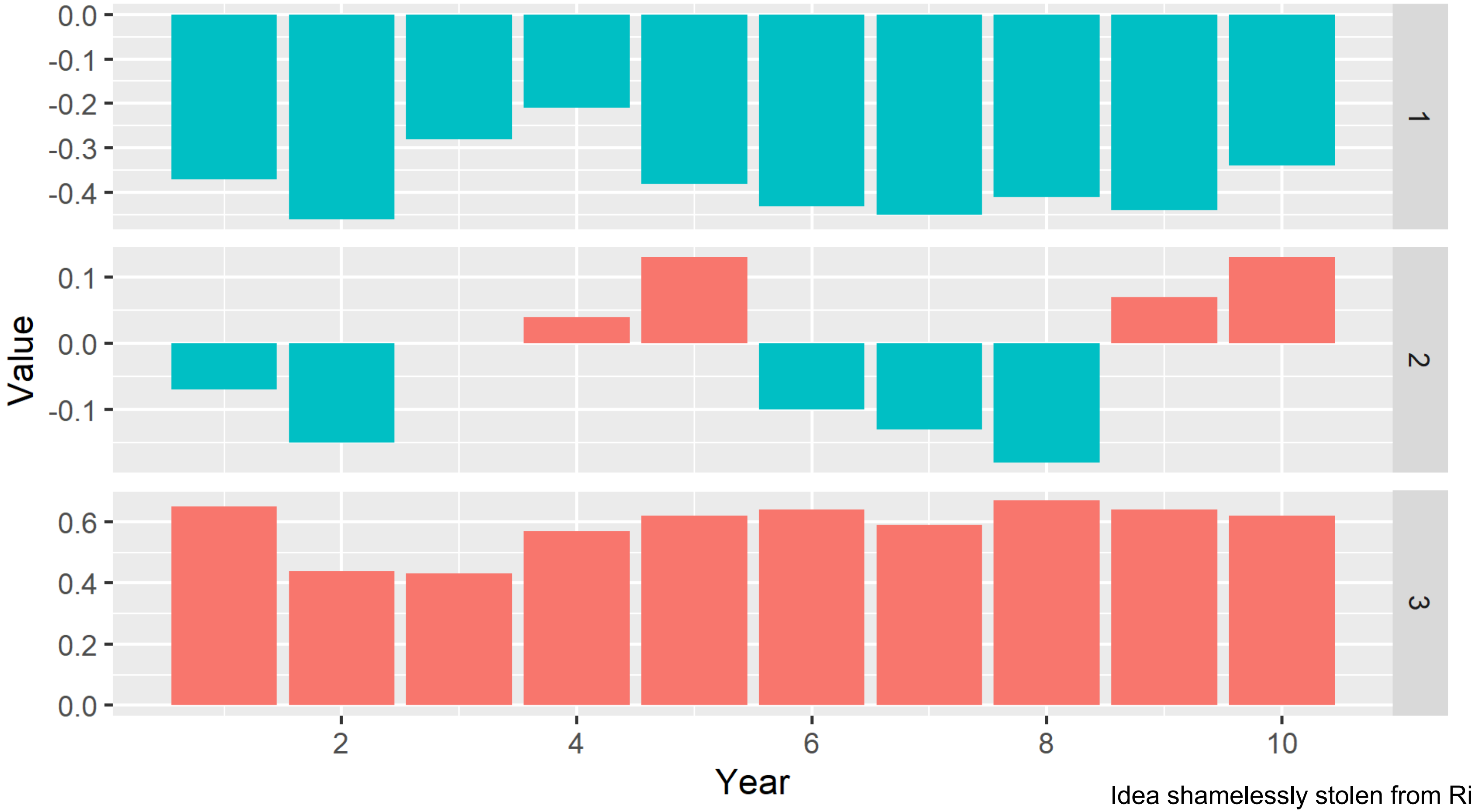
A little experiment…

Which of these 3 data series exhibit a trend?



Idea shamelessly stolen from Richard Dixon, *CatInsight*

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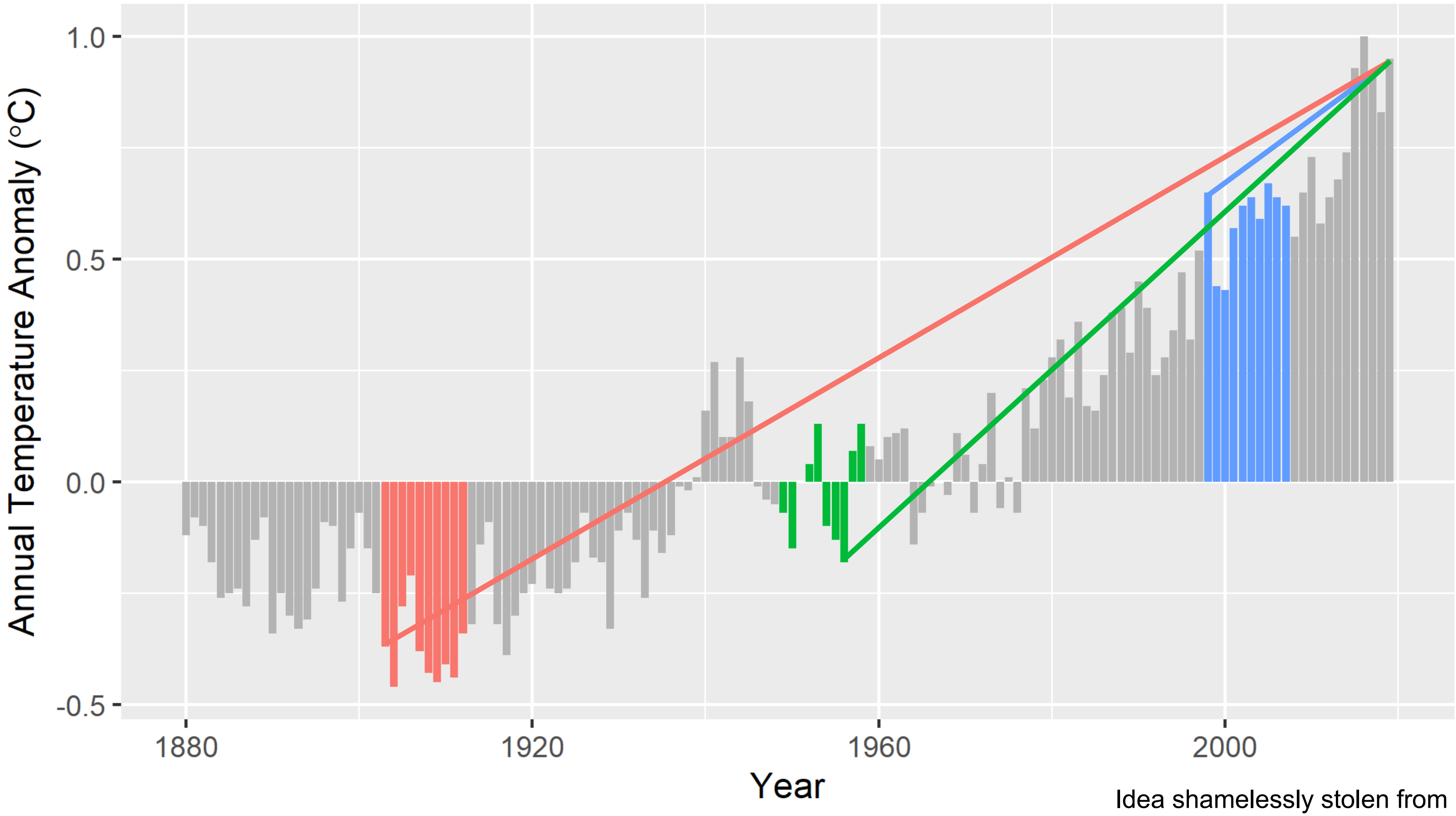
A little experiment…

Which of these 3 data series exhibit a trend?



Idea shamelessly stolen from Richard Dixon, *CatInsight*

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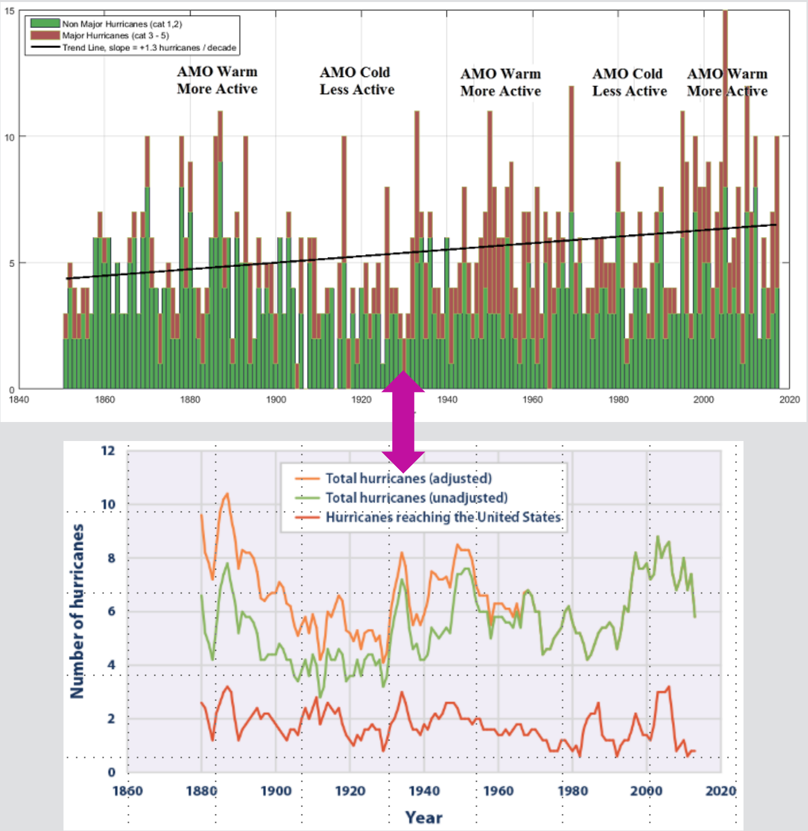
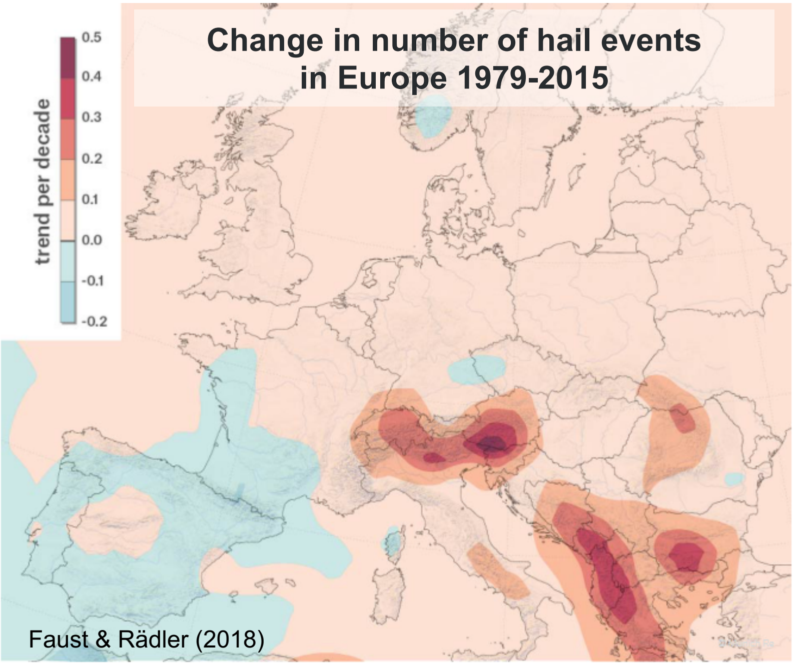
Other phenomena are not so straight forward (1)

Trends in underlying climate data – Tropical Cyclones & Severe Convective Storms



*"Confidence remains **low for long-term (centennial) changes in TC activity**, after accounting for past changes in observing capabilities. However, for years since 1970s, it is **virtually certain that frequency and intensity** of storms in **North Atlantic have increased**, although the **reasons for this increase are debated**."* – **AR5**



A study based on reanalysis data (ERA-Interim) shows that European **hailstorms have become more frequent** over the last 37 years, especially in Austria, northern Italy, Switzerland and the Adriatic coast

Fundamental to ensure any catastrophe model appropriately represents current climate, its variability, and associated losses before considering impacts under uncertain climate change projections

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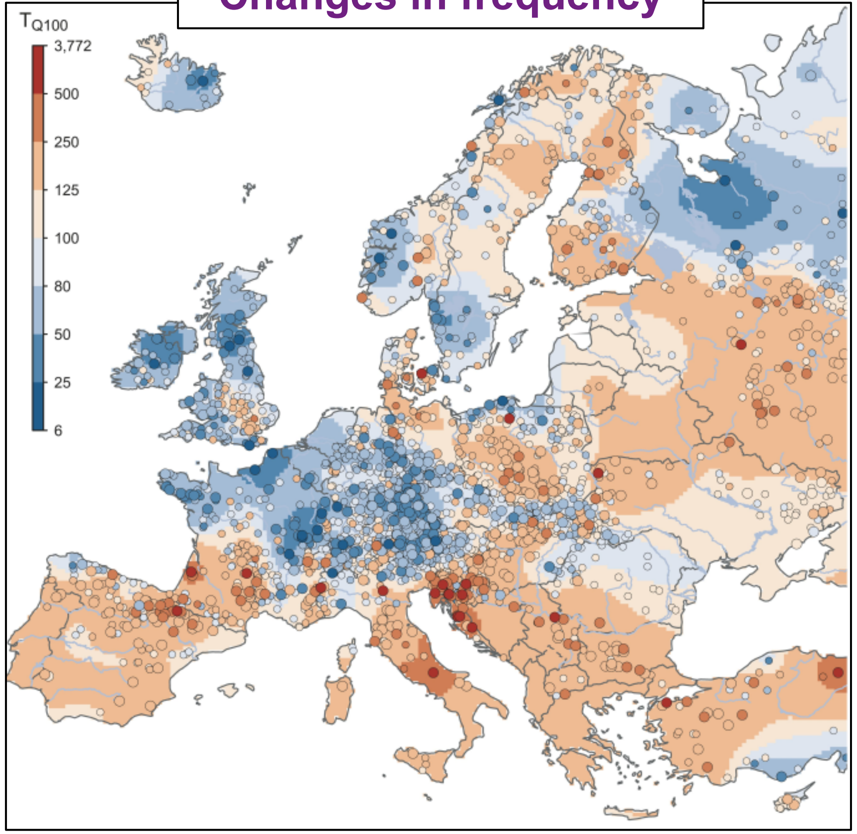
Other phenomena are not so straight forward (2)

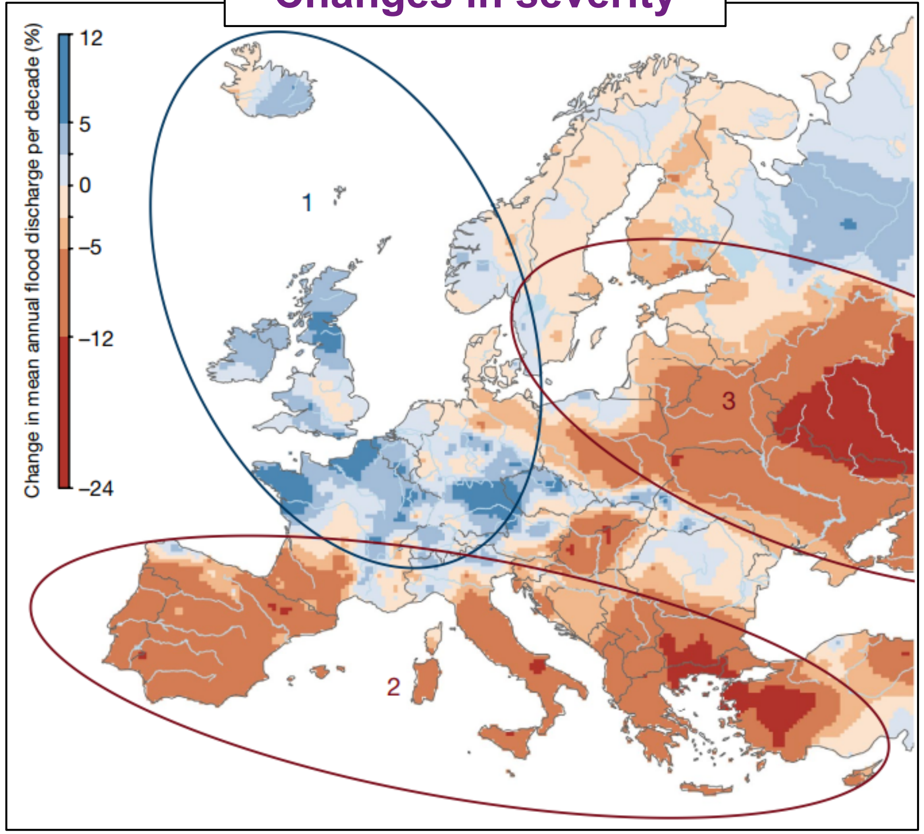
Trends in underlying climate data – Floods

Changes in frequency

Estimated return period in 2010 for the 1960 100-year flood discharge



Changes in severity



Observed regional trends of river discharges in Europe (1960–2010)

- Increase
- Decrease

Fundamental to ensure any catastrophe model appropriately represents current climate, its variability, and associated losses before considering impacts under uncertain climate change projections

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The Ghost of (Christmas) Past

How well do catastrophe models represent the past?

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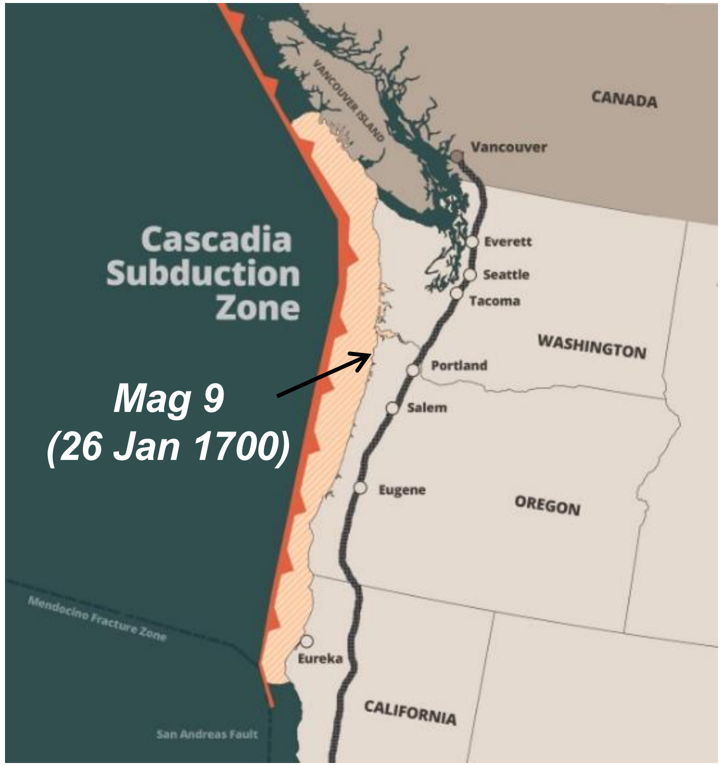
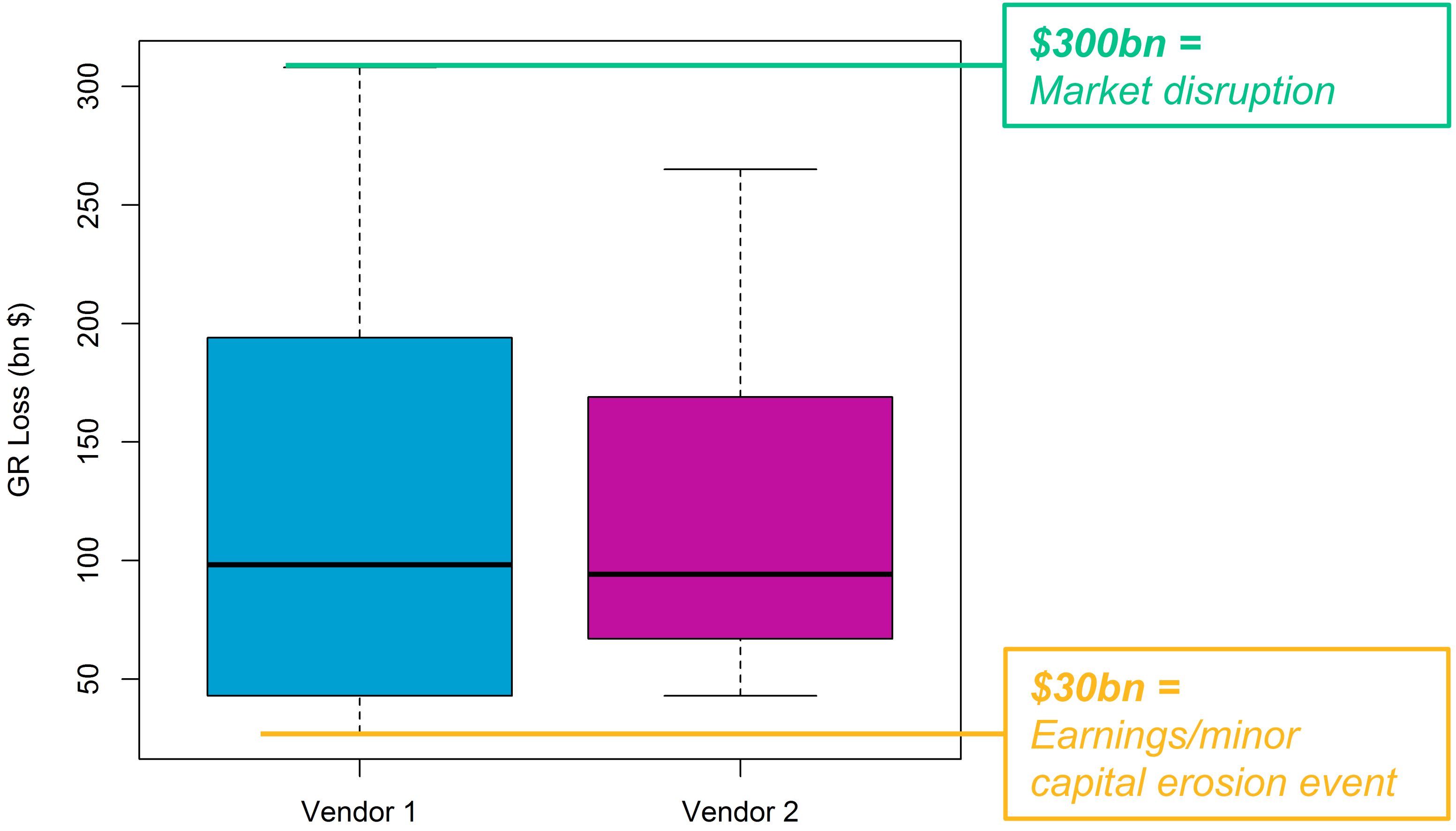
Representation of the distant past

Earthquakes in the 1700's



Cascadia subduction zone (source: FEMA)



Market loss range for extreme events in Cascadia, similar to the 1700 M9 earthquake

Extreme earthquake risk estimates contain huge uncertainties

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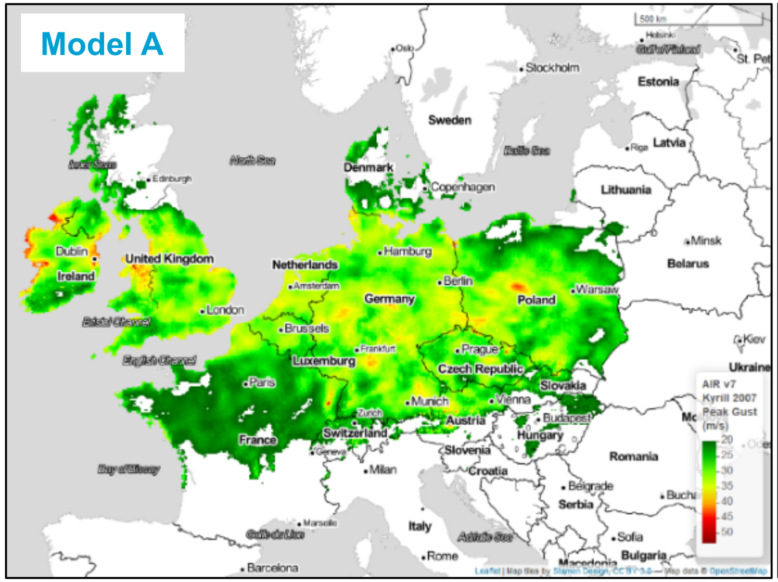
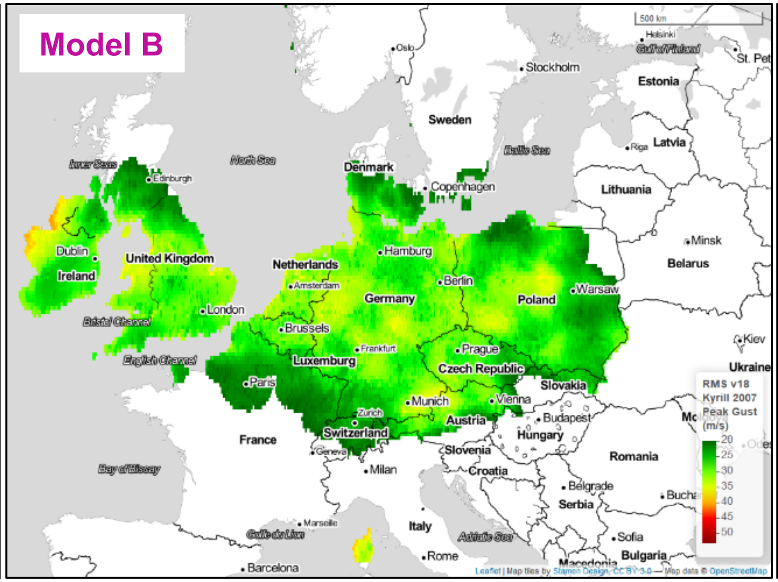
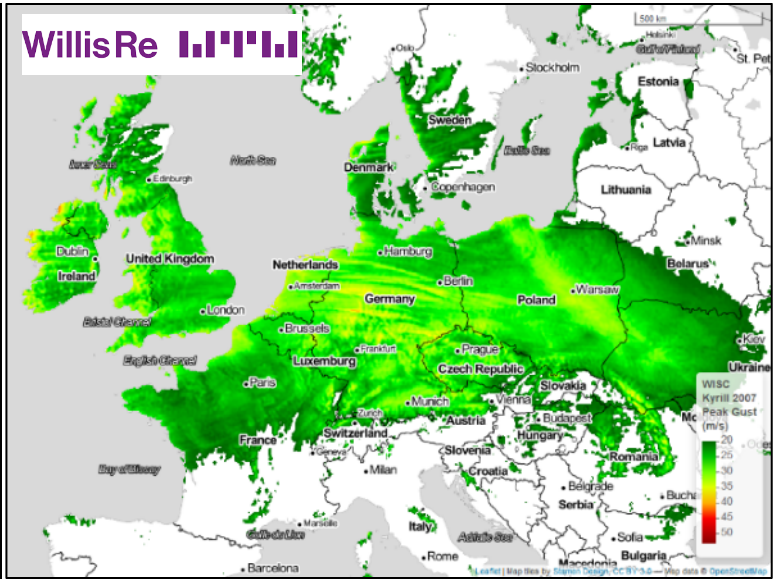
Representation of historical event footprints

European Windstorms







- Catastrophe models incorporate **representations of historical events** – increasingly important for back-testing and model validation for regulators
- **Substantial variability** in historical data and model methodologies used to construct footprints
- Although practitioners validate model components, should we consider the models only as **loss models**?

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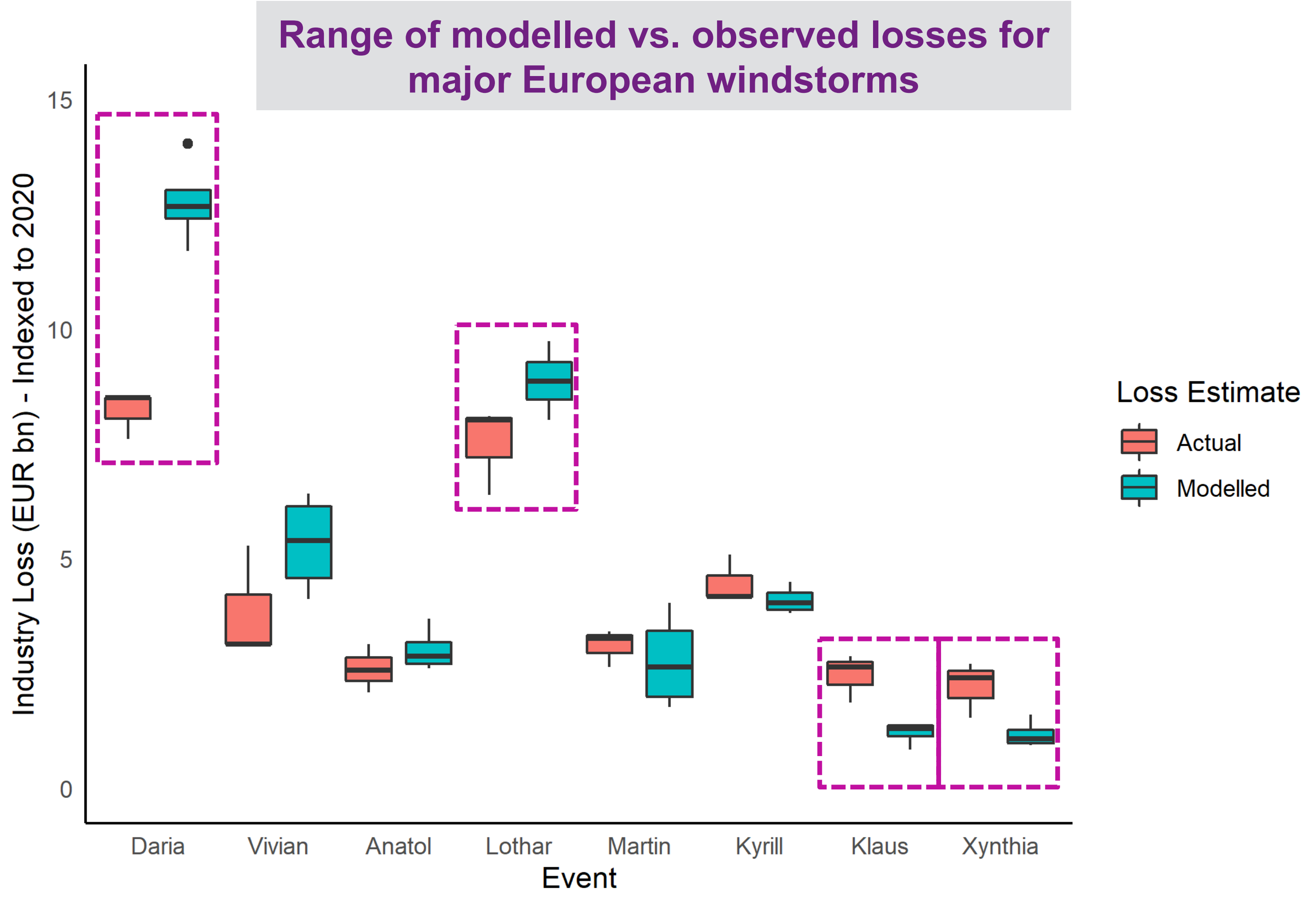
Representation of historical event losses

European Windstorms



- For major historical events, should catastrophe models be able to **replicate observed loss**?
- No pattern related to **event magnitude or event age** in model fit
- How should we use catastrophe models if back-testing is a challenge?

"Actual" – Munich Re NatCatSERVICE, Willis Re Estimate, Swiss Re Sigma
"Modelled" – Combination of vendors and model versions

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The Ghost of (Christmas) Present

How well do catastrophe models represent the present (and past)?

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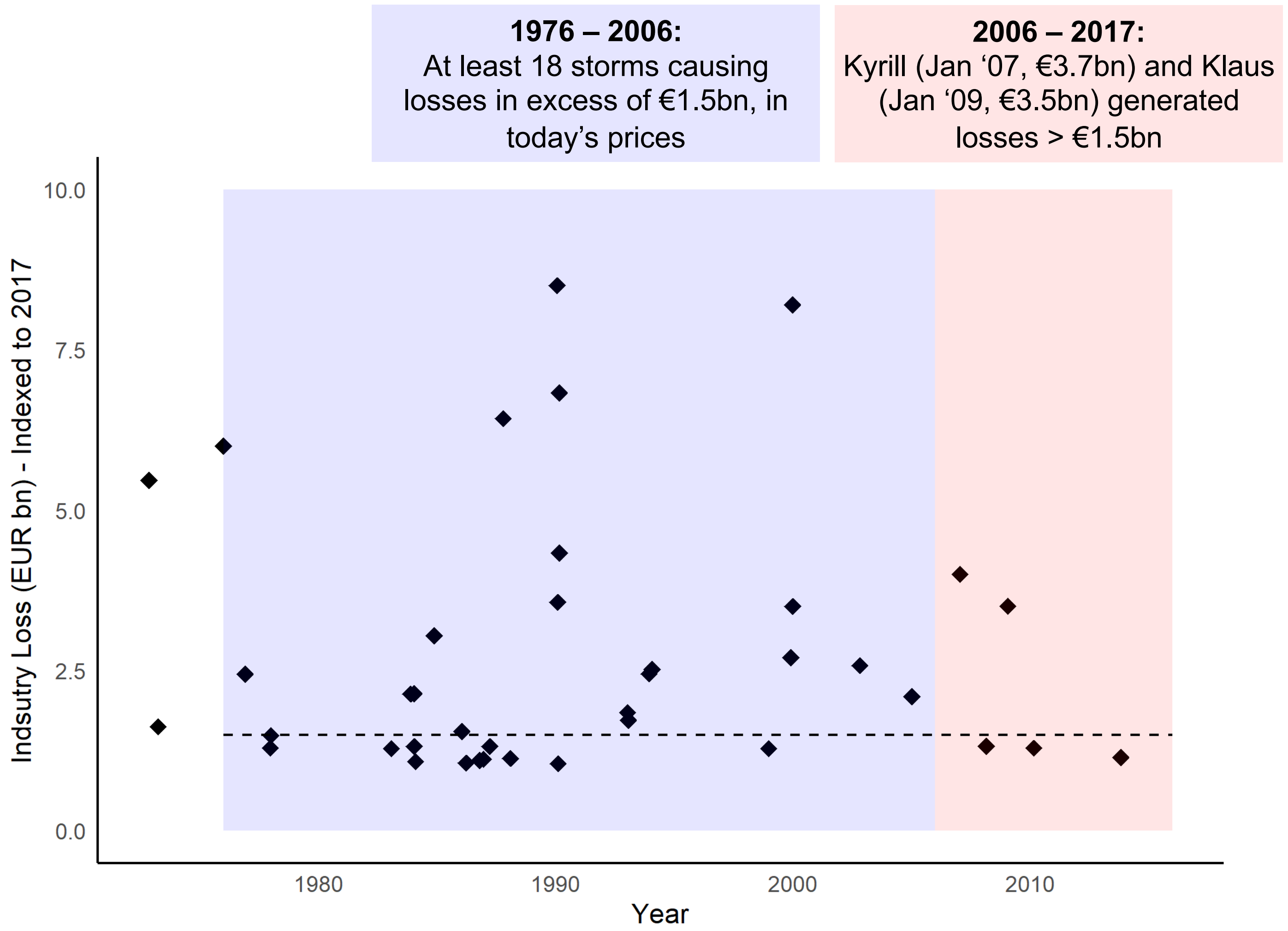
European Windstorms

A review of windstorm activity in Europe



- ~ **6 significant storms** hit Europe every year
- Average annual insured losses of around €3bn (source: PERILS)
- 1976-2006 was around **4 times more 'stormy'** than 2006-2016
- Several studies support the notion that recent climate may persist and that the 80's/90's may have been a "blip"
- Evidence to suggest that the **post-2006 time period** is more typical

European Windstorm market losses indexed to 2017 (source: PERILS)

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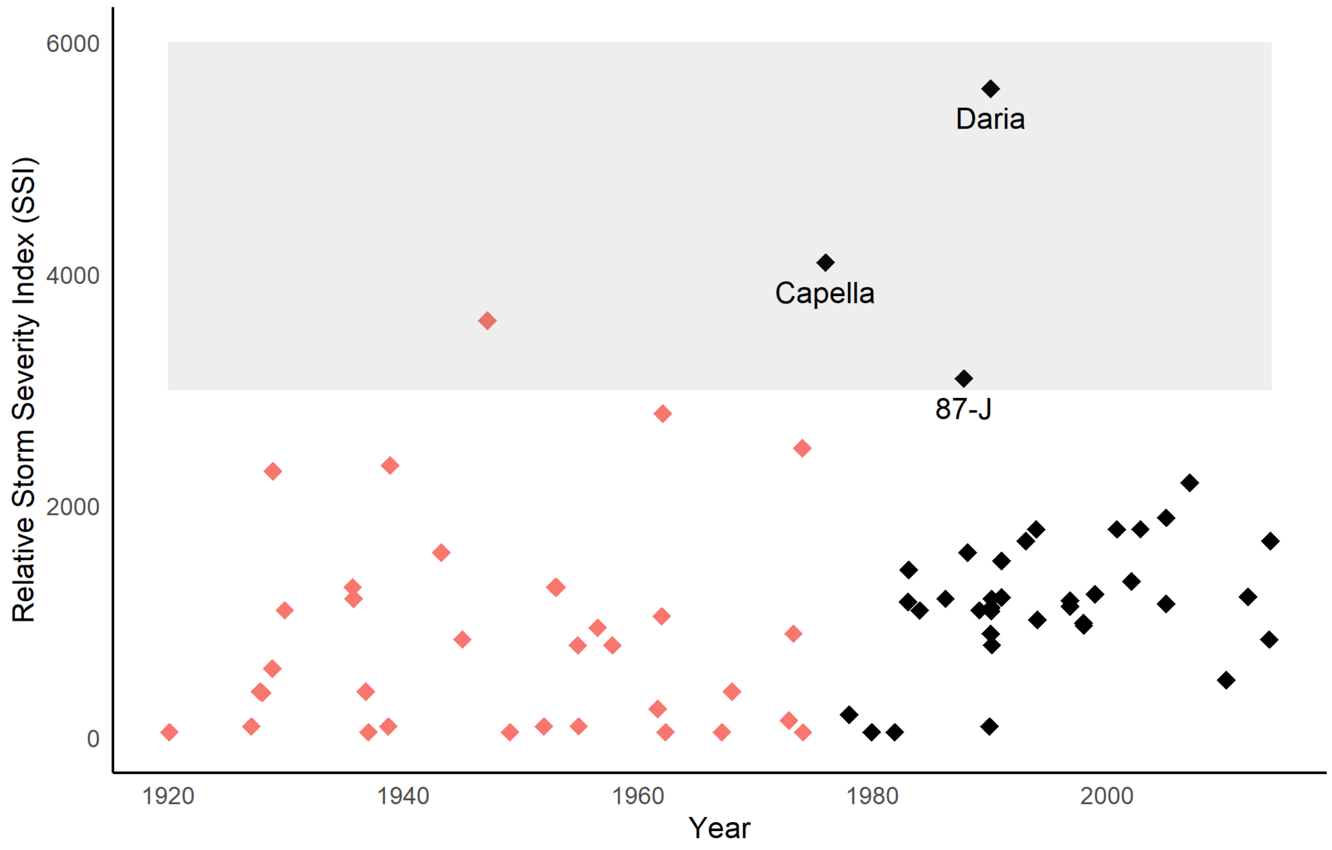
European Windstorms

Extending the record: storminess in UK



- **Extending the record** of windstorms in UK back to 1920 using XWS catalogue and Palutikof et al. (1997)
- Period **post-2006 more representative** of entire record than 1970 – 2006
- Vendor catastrophe models tend to use data from 70s onwards
- Does this bias vendor model output to higher activity period?

What does this mean for modelled view of risk?

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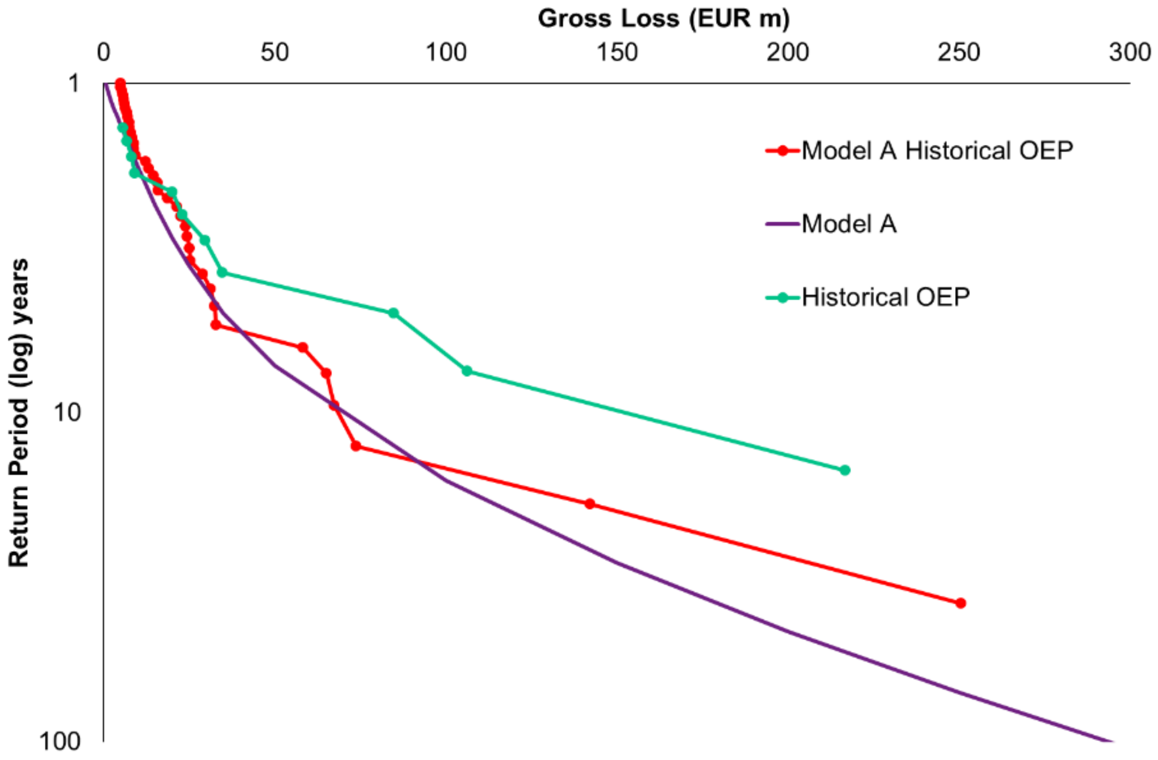
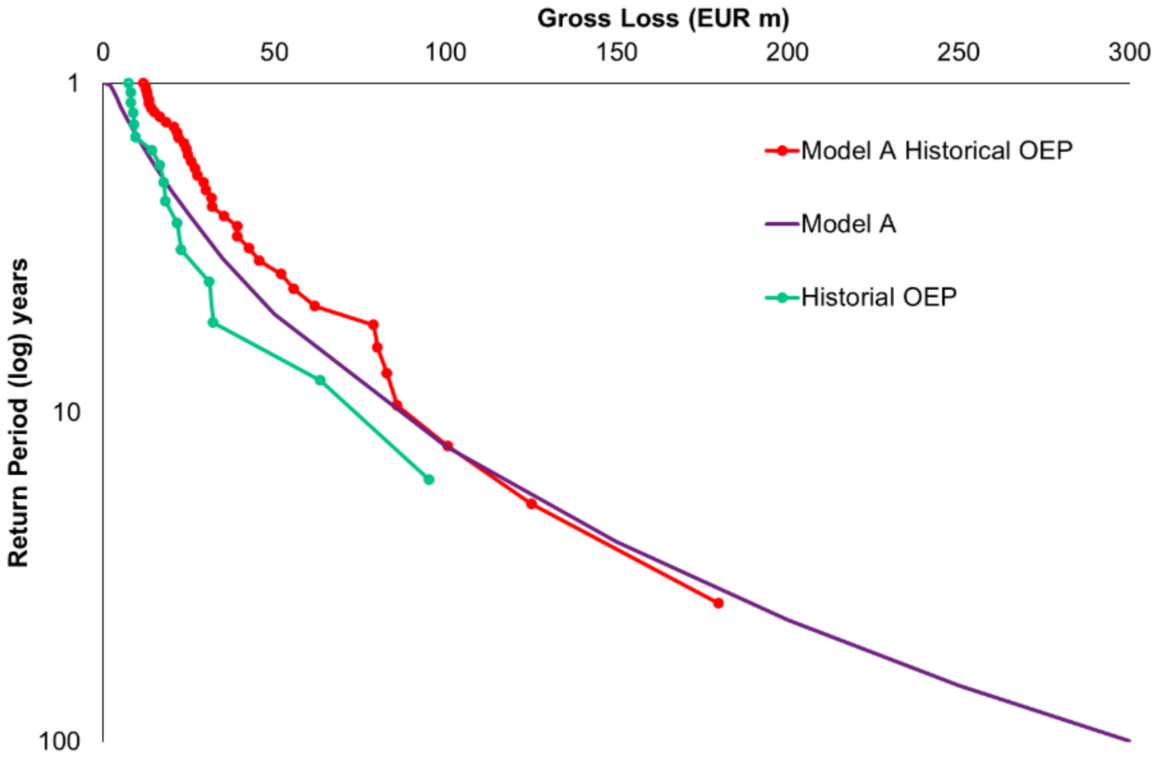
European Windstorms

Representation of the recent past

France



Germany



Solvency II back-testing requirement necessitates a robust representation of recent past – the time period where data quality will be highest and model confidence should be highest

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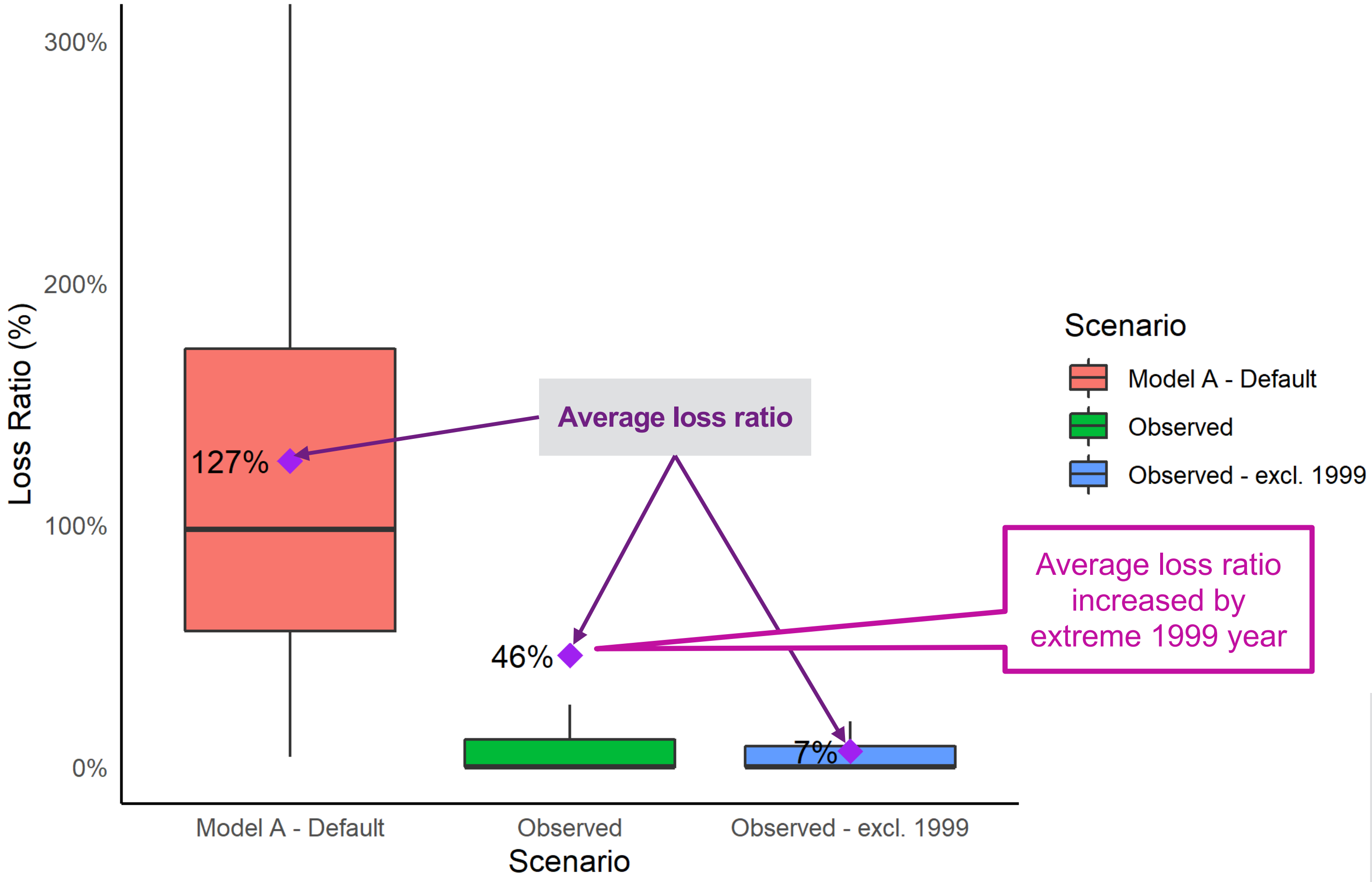
European Windstorms

Analysis of observed vs. modelled loss ratios



- **Willis Re composite treaty portfolio** of insurers and reinsurers writing business in Europe
- Further evidence that **recent years are not as active** as period used to construct catastrophe models

Modelled loss ratios for European windstorms significantly above 20 years of experience

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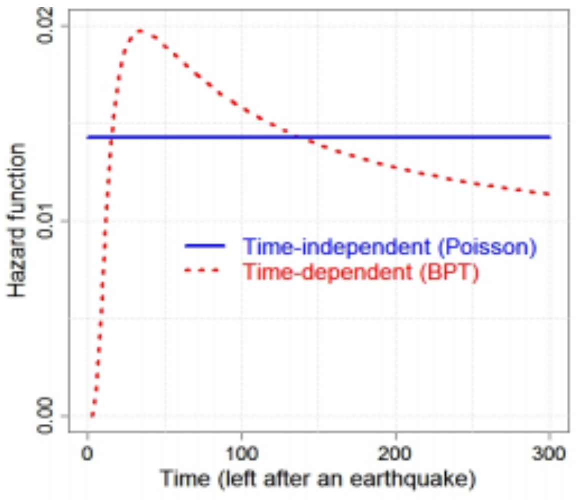
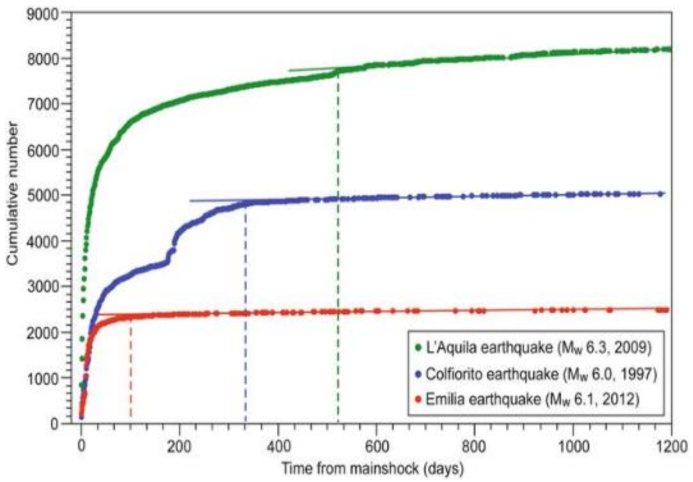
Earthquakes

Which elements are generally modelled and what is missing?



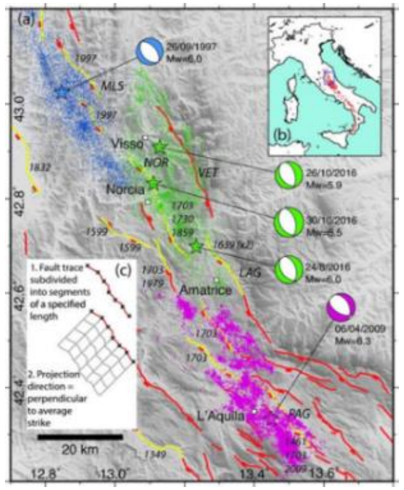
Long term time-dependency

EQ probability depends on "cycle" of the fault



Aftershocks

Seismicity surge after an EQ in proximity to the mainshock



Stress-transfer

Following an EQ, this can change the probability of occurrence for nearby faults

Modelled by vendors	*Modelled in a few cases* - in newer models	*Not Modelled* - only long-term average view is modelled	*Not Modelled* - Vendors provide isolated views post an event
Reinsurance implication	Assessing vertical PML	Assessing adequacy of vertical and sideways cover	Assessing vertical PML

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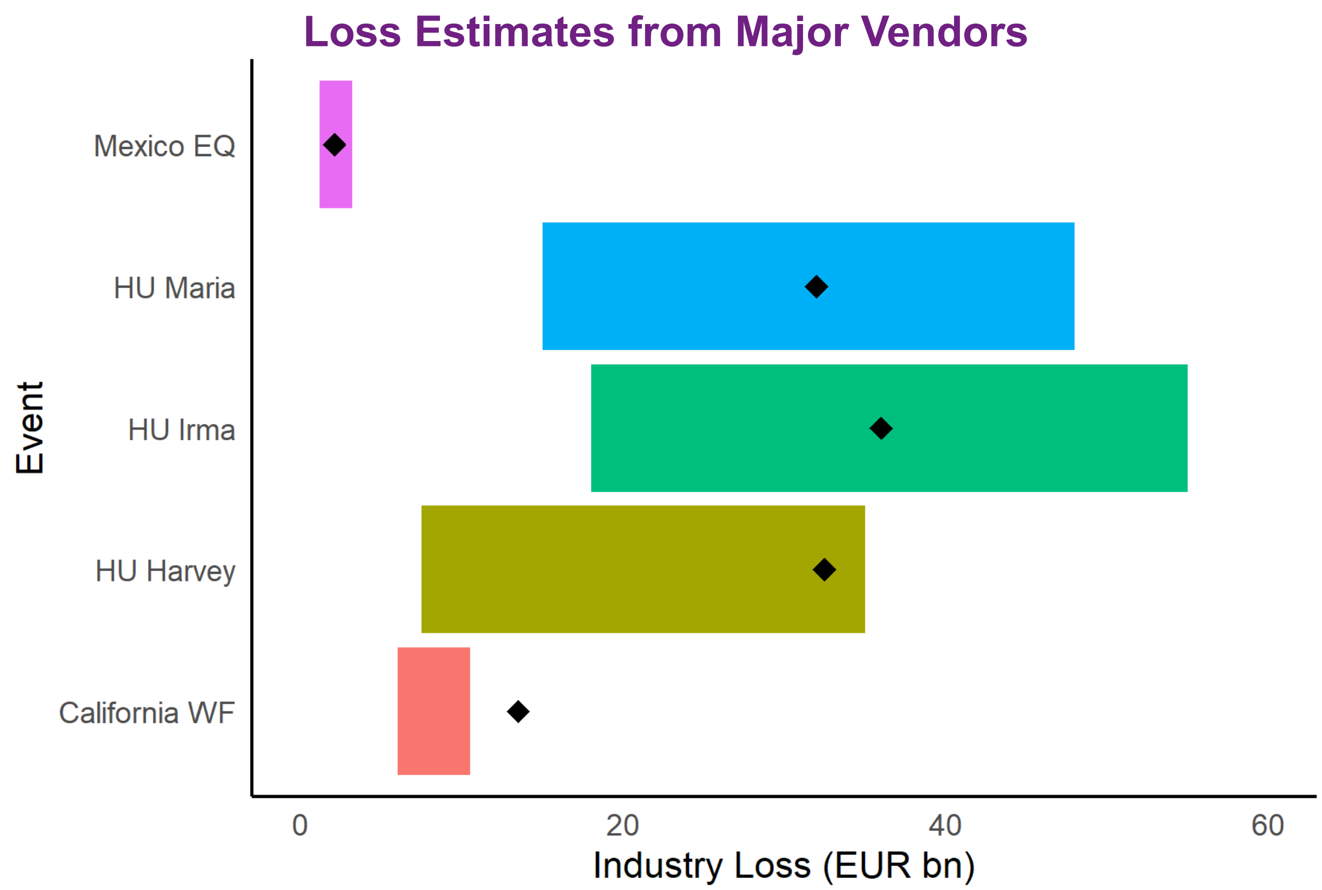
Catastrophe models and live events

How well do catastrophe models represent live events?



◆ "Actual Loss" – Munich Re NatCatSERVICE

- Catastrophe models are **not** designed to model live events in real-time
- Practitioners **expect** catastrophe model vendors to provide appropriate loss estimates for live events
- This dynamic relies on vendor model stochastic event sets representing the full spectrum of event types (e.g. Harvey)

Use catastrophe models to monitor accumulations during live events but ensure own data is used to assess frequency and magnitude of claims

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The Ghost of (Christmas) Yet To Come

How can catastrophe models help us assess the future?

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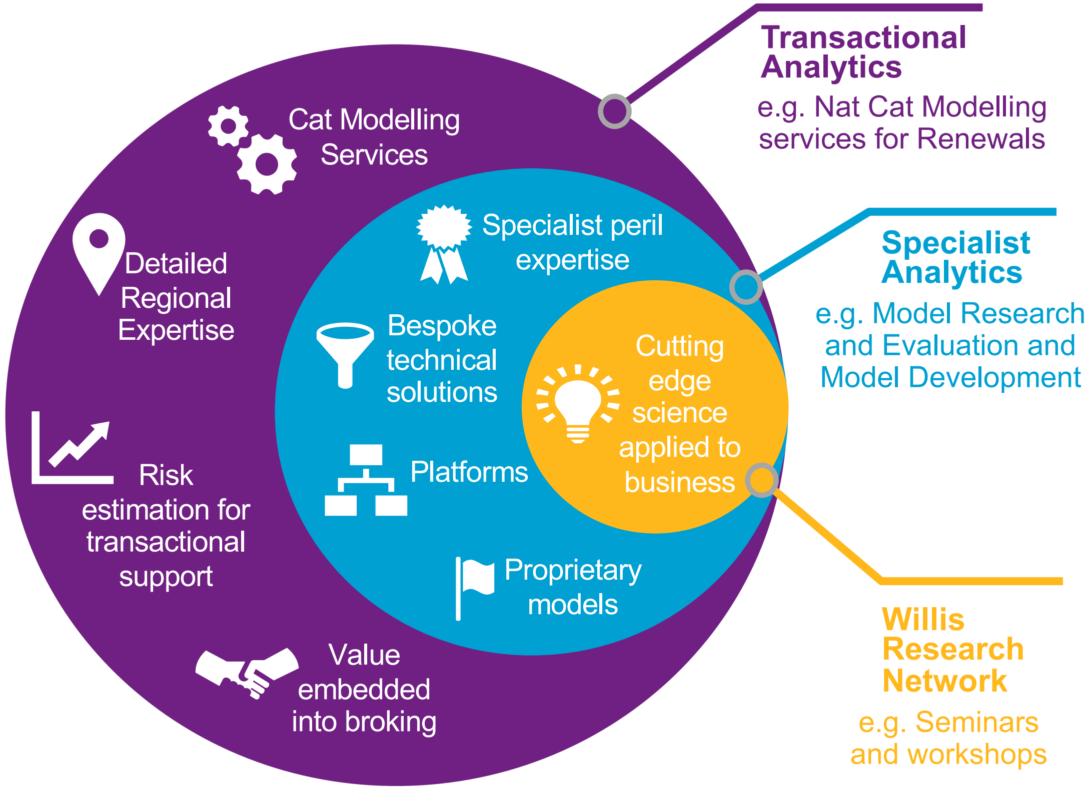
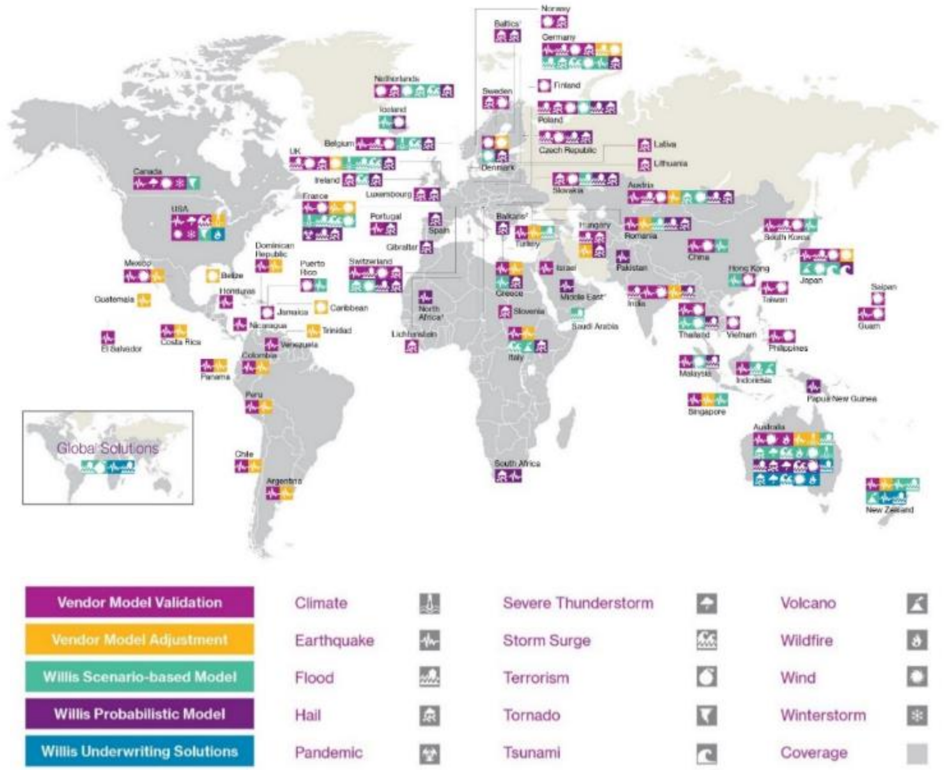
How can catastrophe models help us assess the future?





Customise Own View of Risk and assess delta in OVoR based on climate change scenarios

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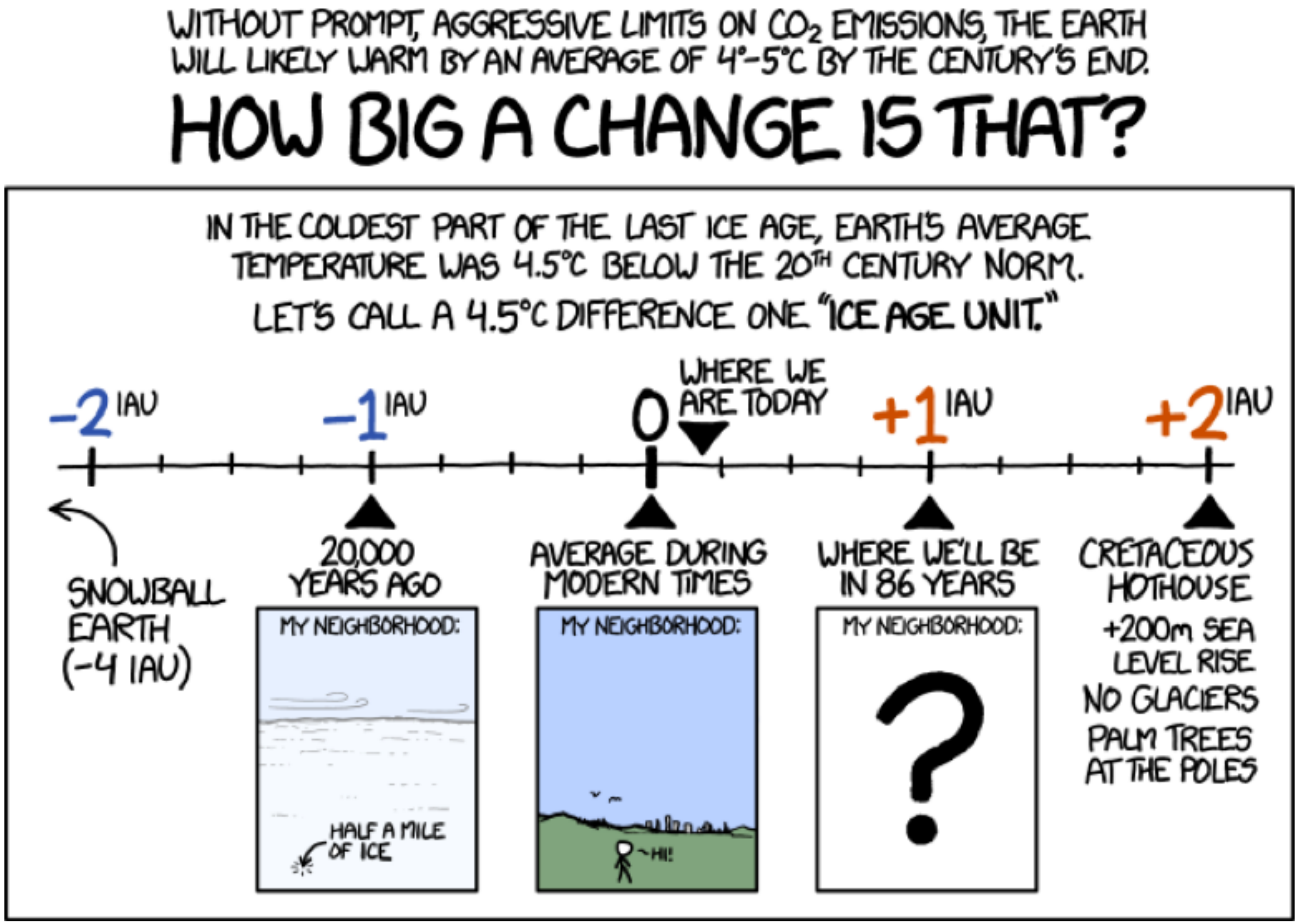
The Ghost of (Christmas) Yet To Come



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Willis Climate Risk Service Offering Framework

1. Motivation

Why look at this?

2. Business impact

How much does this affect business?

3. Apply the science

Collate research and determine practical application

4. Assess and quantify

Consider available tools and quantify impact of climate change risk

5. Reporting

Communicate findings and assumptions

6. Action

Risk transfer, business change advisory and decisions

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US Hurricanes

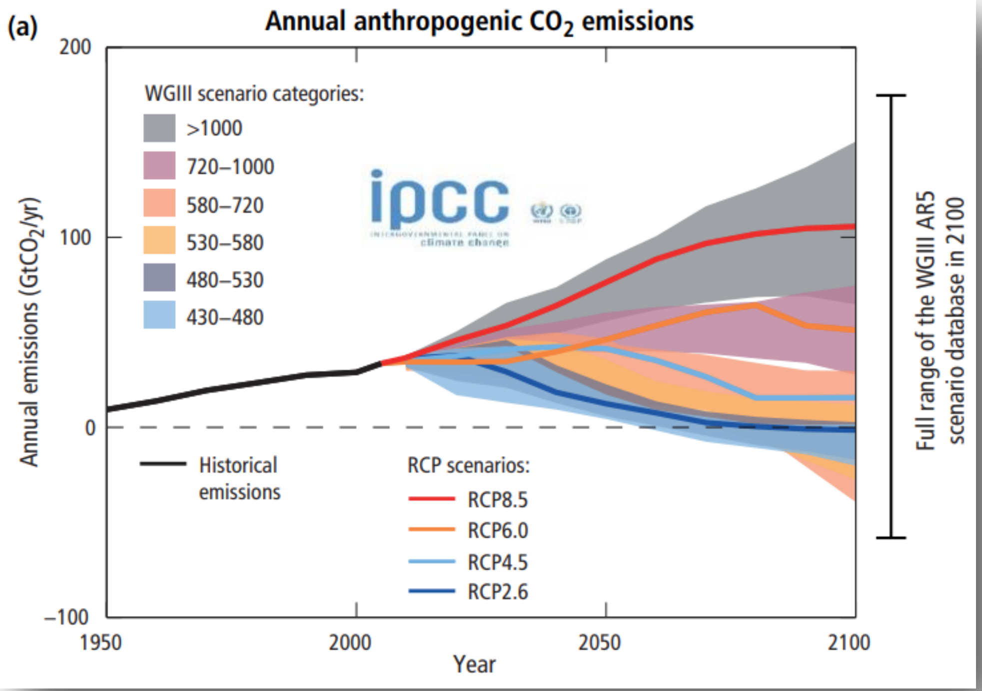
Future Projections

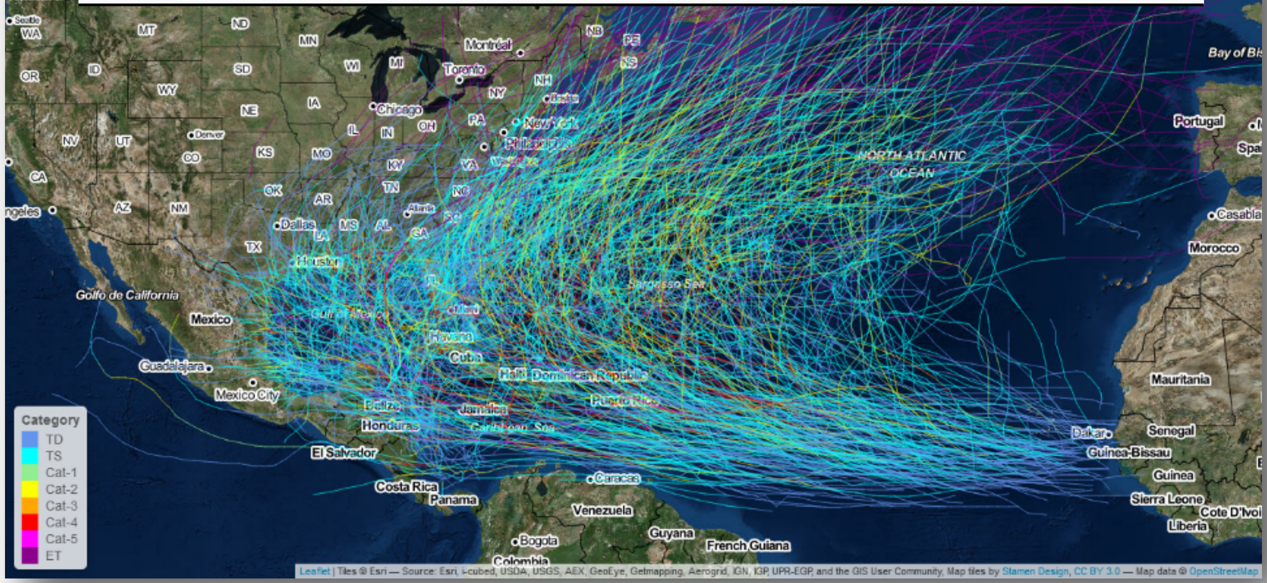
5th Assessment Report (AR5) - 2014 - IPCC
(Intergovernmental Panel on Climate Change)

- Four Representative Concentration Pathways (RCP) climate scenarios for 2080-2100

Projected impacts by RCP in 2100 (source: IPCC AR5)

Scenario	Associated climate policy	CO2 Equivalent (ppm)	Temperature (°C) Mean [range]
RCP2.6	Mitigation	475	1.0 [0.3 to 1.7]
RCP4.5	**Stabilization**	**630**	**1.8 [1.1 to 2.6]**
RCP6.0	Stabilization	800	2.2 [1.4 to 3.1]
RCP8.5	None	1313	3.7 [2.6 to 4.8]





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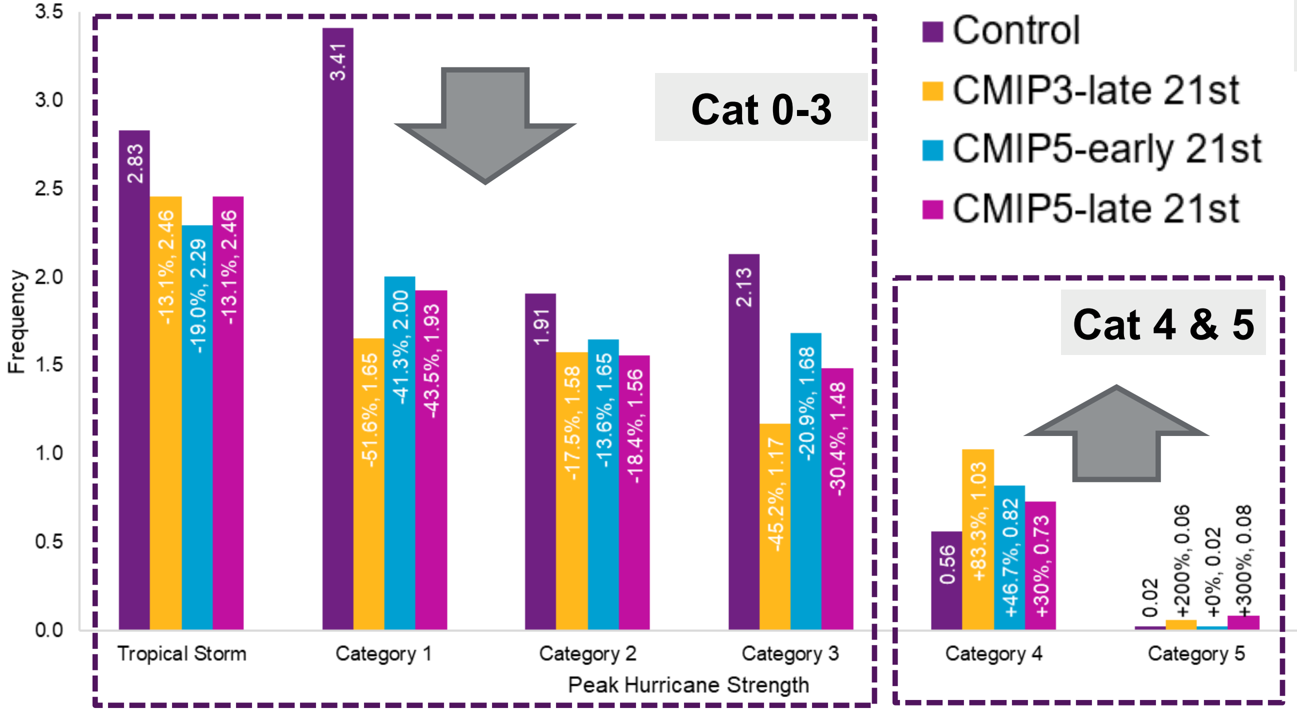
US Hurricanes

Future Projections

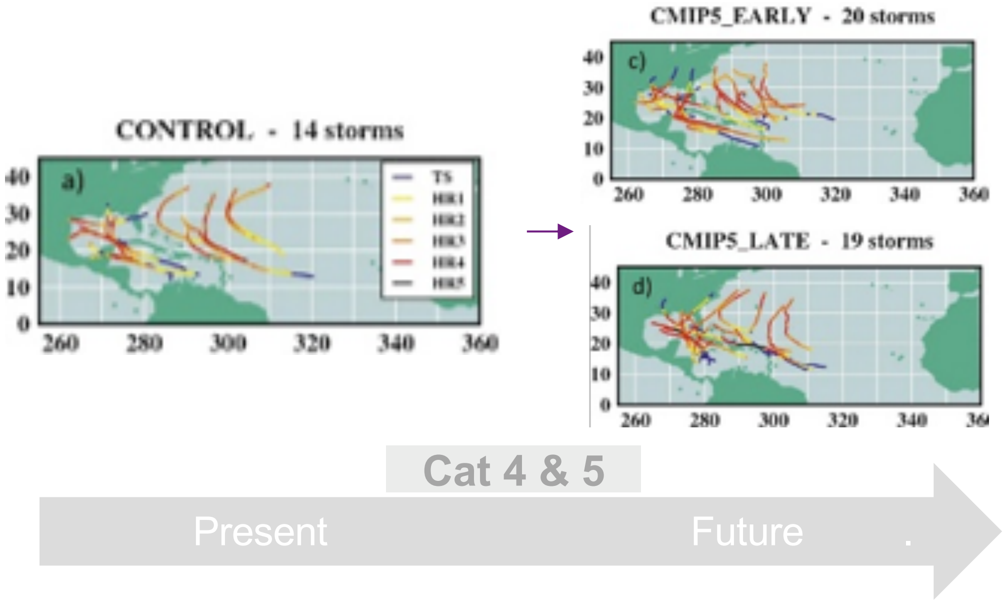
Knutson et al. (2013) – CMIP3 & 5 – RCP4.5

- Frequency changes for **Early and Late 21st century**, compared to control simulation for 1980-2006 (of GFDL and GFDN models)



Change in frequency by peak strength - Knutson et al. (2013)

Variable	Control	% change (p level) CMIP3	CMIP5-early	CMIP5-late
Ts (cat 0)	2.83	−13.1 (0.10)	**−19.0 (0.04)**	−13.1 (0.07)
Hur (cat 1)	3.41	**−51.6 (<0.01)**	**−41.3 (<0.01)**	**−43.5 (<0.01)**
Hur (cat 2)	1.91	−17.5 (0.17)	−13.6 (0.23)	−18.4 (0.10)
Hur (cat 3)	2.13	**−45.2 (<0.01)**	−20.9 (0.10)	**−30.4 (0.01)**
Hur (cat 4)	0.56	**83.3 (0.01)**	46.7 (0.05)	30.0 (0.21)
Hur (cat 5)	0.02	200.0 (0.37)	0.0 (—)	300.0 (0.31)



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US Hurricanes

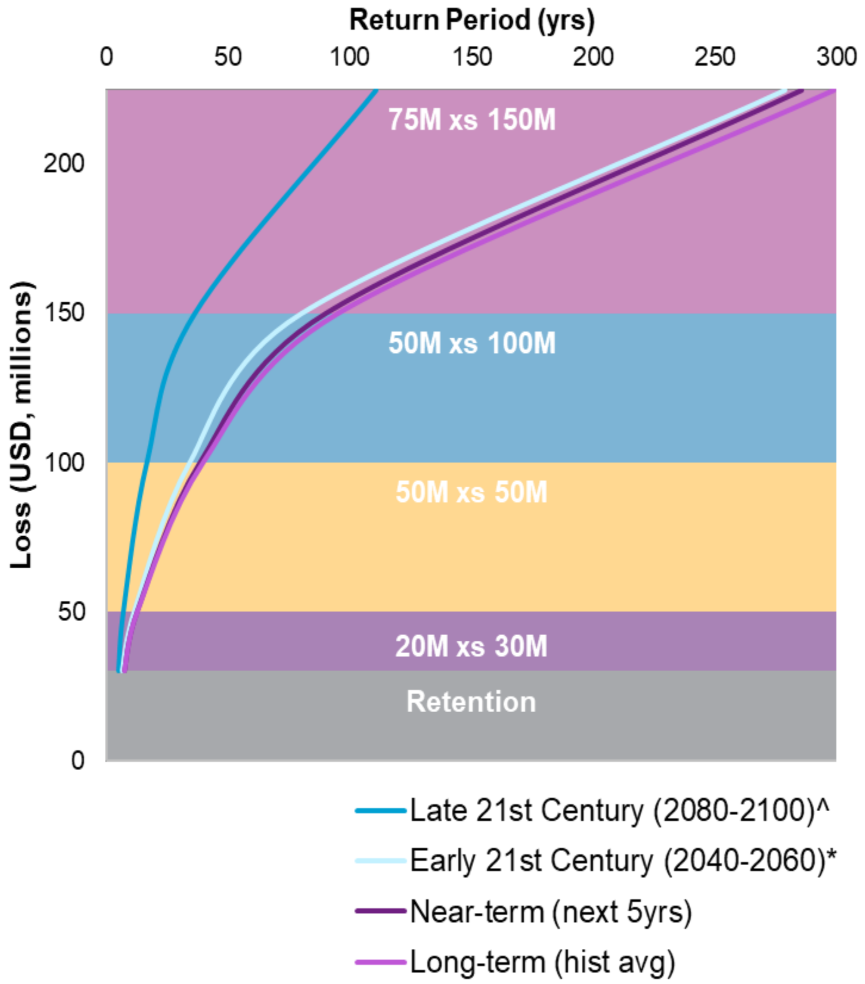
Impact of Future Projections

Property Cat XOL - Layer exit point return periods

Cat XOL Layer	Vendor		Climate Change	
	Long-term	Near-term	*Early 21st	^Late 21st
$75M xs $150M	299	286	279	111
$50M xs $100M	**95**	**90**	**80**	**36**
$50M xs $50M	40	38	34	17
$20M xs $30M	13	13	12	7
Retention	8	7	7	5

** RCP 4.5 from CMIP5 model projection*
^ RCP 4.5, average of CMIP3 & 5 model projections

- Near-term view (next 5 yrs) - similar to Early 21st century view
- Marked decrease in exit-RPs for Late 21st century view



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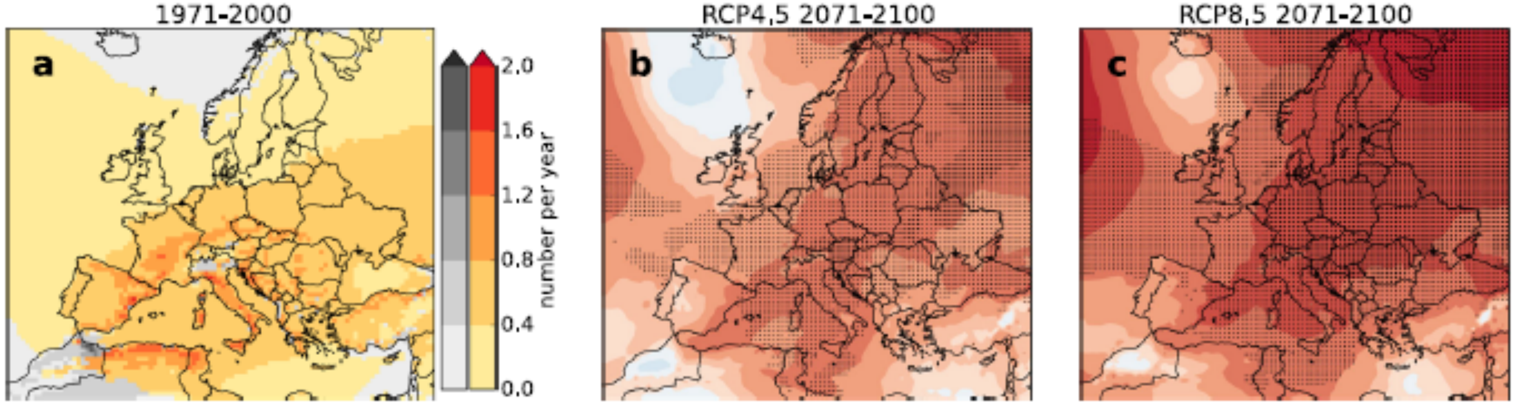
European Hail

Future Projections

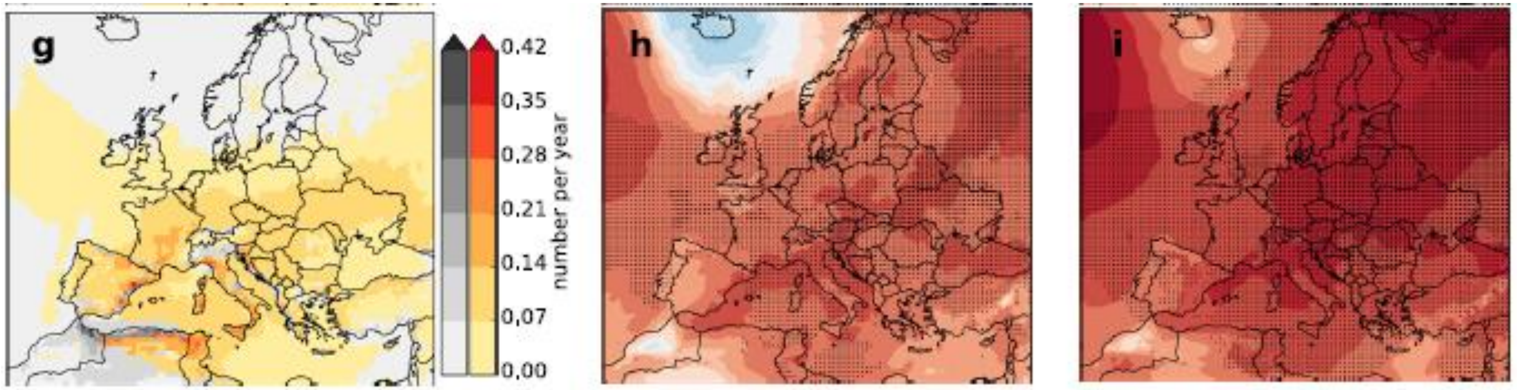
By 2071-2100, a **strong and robust relative increase** is expected across northern and eastern Europe based on ensemble of 14 regional climate models for two climate scenarios (RCP 4.5, RCP 8.5)

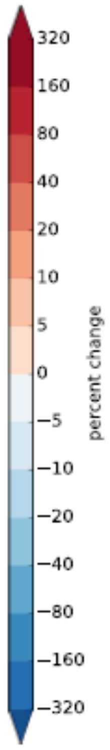
Change in occurrence of large hail **(≥2 cm diameter)**

Rädler et al. (2019)



Change in occurrence of large hail **(≥5 cm diameter)**





The occurrences of large hail (≥2 cm diameter) and of damaging convective winds are found to increase, with a robust upward trend across most regions. Large hail is projected to become **40–80%** more likely across central and eastern Europe in the RCP8.5 scenario by the end of the century.

The evolution of hail with diameters of ≥5 cm, causing most severe damage to crops, cars and property, is robustly projected to become **more likely** across most of Europe, with a doubling possible in parts of central and northeastern Europe in the RCP8.5 run

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European Hail

Impact of Future Projections

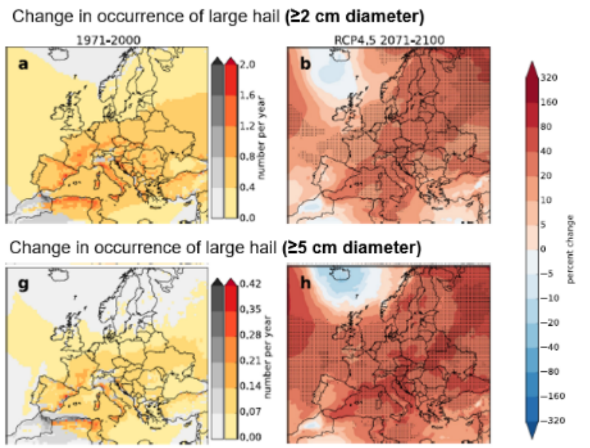
Research projected change in hail frequency from academic review

Translate to assumptions that can be applied to probabilistic models

Recalculate losses and compare to baseline

Frequency change Germany

	RCP 4.5	RCP 8.5
≥2 cm diameter	20 - 40%	40 - 80%
≥5 cm diameter	20 - 40% / 40 - 80%	80 - 160%



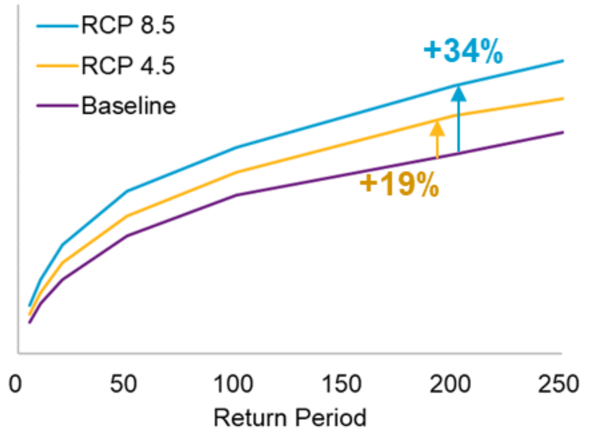
Change rate of events by

	RCP 4.5	RCP 8.5
high frequency	30%	60%
low frequency	50%	120%

EventId	Rate	Gross Loss	Standard Deviation	Exposure
1029430	0.000040	2,349,071,932	74,176,883	1,663,632,351,209
1041456	0.000040	2,105,279,689	75,349,375	1,280,222,457,489
1041714	0.000040	2,020,083,960	76,287,239	1,306,573,580,563
1029431	0.000040	1,679,229,077	70,675,810	1,645,973,203,245
1041982	0.000040	648,698,880	42,931,231	927,180,983,720
1029754	0.000160	640,973,222	49,530,527	737,407,759,971
762674	0.000040	632,454,705	33,636,253	785,487,151,192
789428	0.000160	632,406,365	43,775,931	503,721,232,258
1041212	0.000040	630,630,734	35,069,477	1,477,777,971,740
855264	0.000160	54,534,669	4,645,325	551,270,520,691
1041796	0.000320	54,533,565	7,434,172	467,040,639,981
1000709	0.000040	54,530,574	4,439,028	723,809,634,687
1054077	0.000160	54,527,877	6,642,860	738,872,357,355
1053352	0.000160	54,522,019	7,098,033	331,981,978,950
1013252	0.000040	54,504,238	5,606,409	397,409,052,883
908737	0.000160	54,495,074	6,216,064	306,262,598,284
1063317	0.000040	54,477,025	4,635,496	391,417,573,042
788426	0.000160	54,474,667	6,323,569	350,744,069,222
1041764	0.000364	54,466,515	6,036,329	571,764,871,499
989242	0.000364	54,440,274	11,515,591	246,169,851,683
890502	0.000040	54,439,033	5,276,218	410,763,662,386

Overall impact

- RCP 4.5: AAL: +34%, 200 yr: +19%
- RCP 8.5: AAL: +72%, 200 yr: +34%



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Conclusions

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Conclusions

Past & Present

Constructing a robust **Own View of Risk** that is not dependent on a single vendor catastrophe model is imperative

Use the catastrophe models to **inform rather than set a strategy** → ensures that model change or license changes do not impinge on business continuity

Use catastrophe models to monitor accumulations during live events but **trust own loss experience**

Future

Catastrophe models and scenario stress testing is an effective way to examine the **delta on existing view of risk** to assess impacts of climate change

Future scenarios are **highly uncertain for many major perils** (e.g. European windstorms) but "playing a game" with the models can guide strategy

Engage early with experts and regulators to ensure climate change is incorporated into future vision

Helping clients respond to regulators, address earnings volatility, determine capital adequacy and reinsurance protection limits

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How well do catastrophe models represent the past, the present, and the future?

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MORO: Series of reinsurance webinars, 2pm BST

Emerging risks and opportunities in agriculture

Friday 12

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