MANAGING EXTREMES Willis Re

CLIMATE CHANGE AND CATASTROPHE MODELS

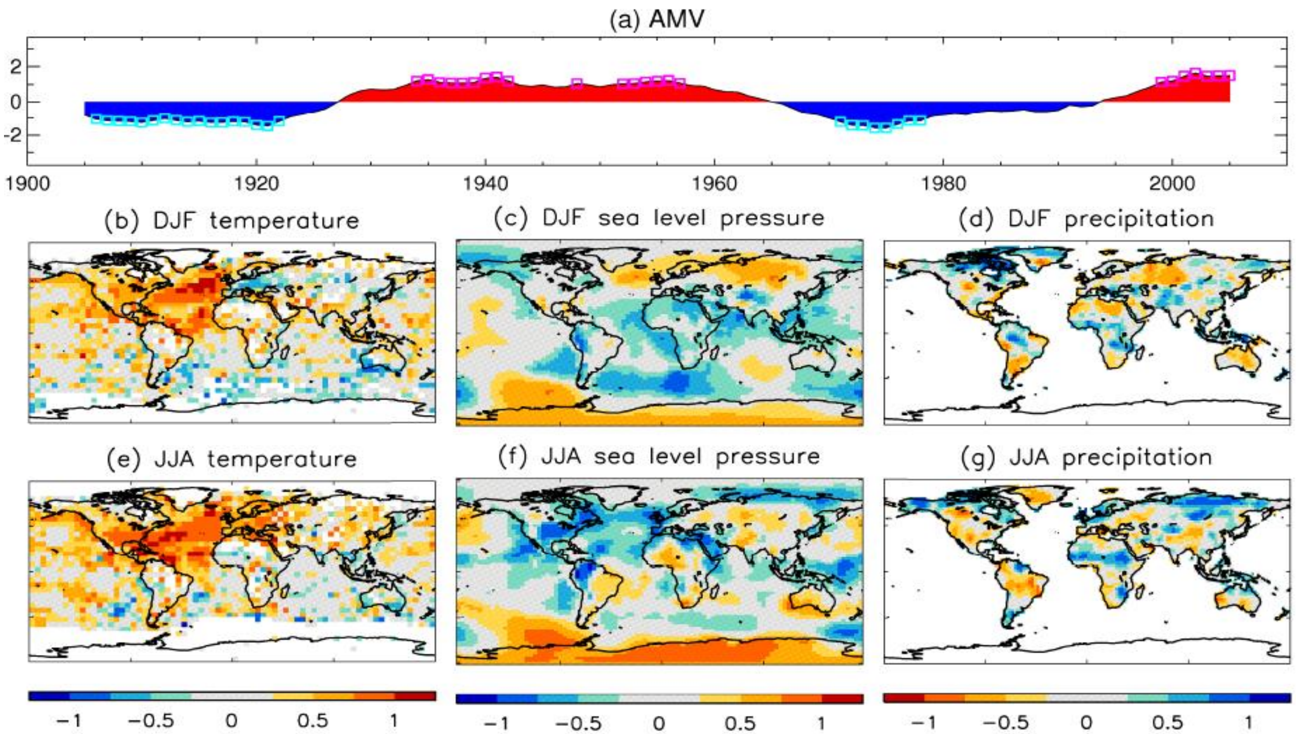
Dr. Rick Thomas

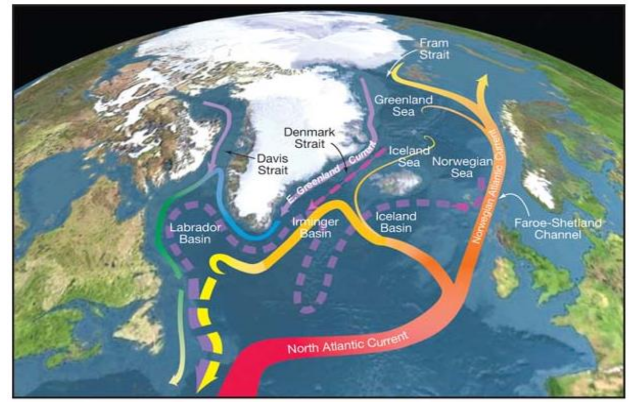
Willis Re

Overview

- Partially modeled examples
  - Atlantic Hurricane medium term rates: AMO…. or climate change?
- Non-modeled example
  - European Hail: is there really an increase in loss frequency and severity as recent losses appear to suggest?

Atlantic multi-decadal variability (AMV)





- Potentially predictable changes in Atlantic currents can change sea surface temperatures for decades
- Important climate impacts in Europe, North and South America, Africa, and Atlantic hurricanes

Smith *et al*, 2012; Dunstone and Smith 2010

U.S. hurricanes AMO/AMV

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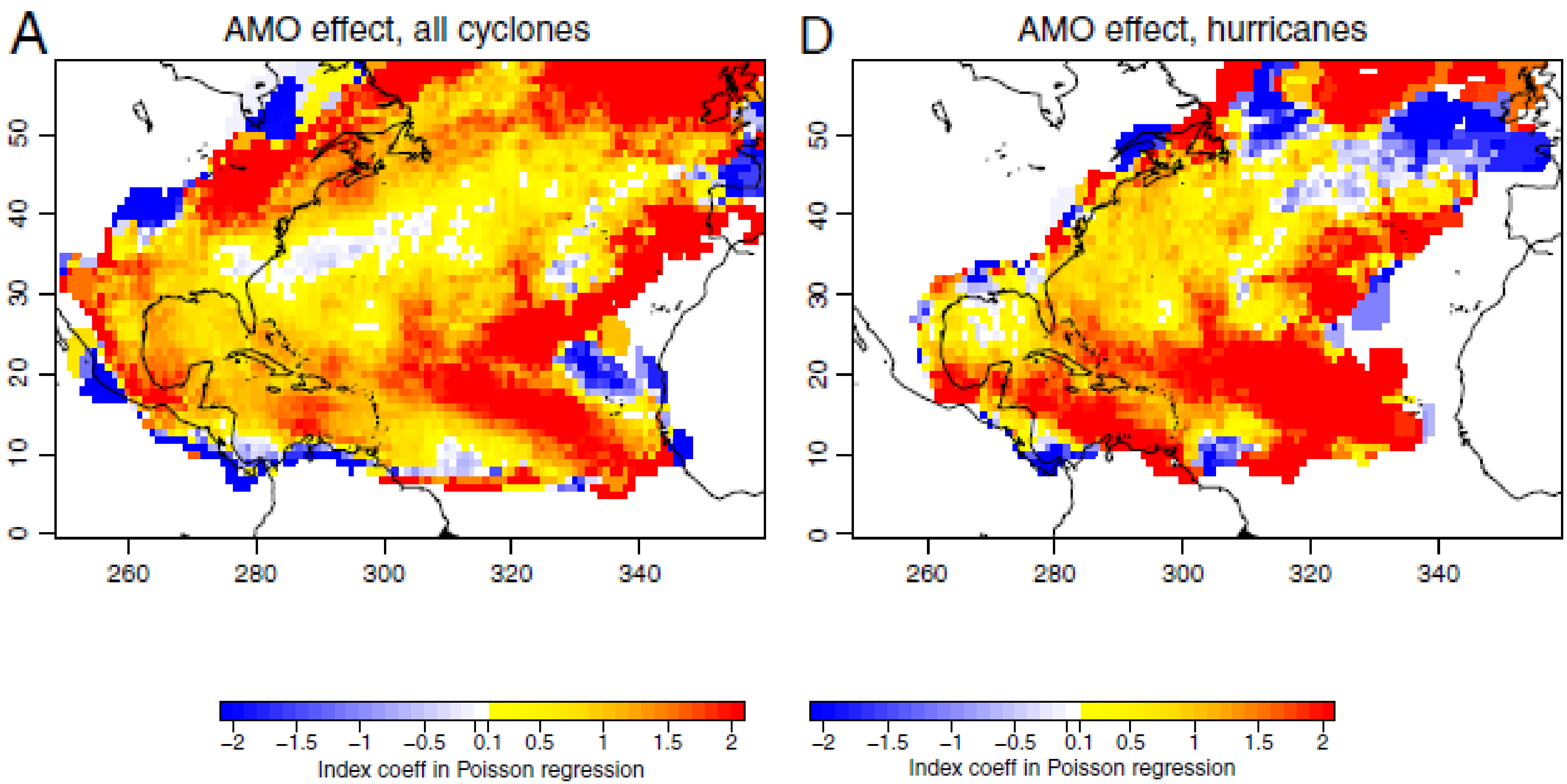
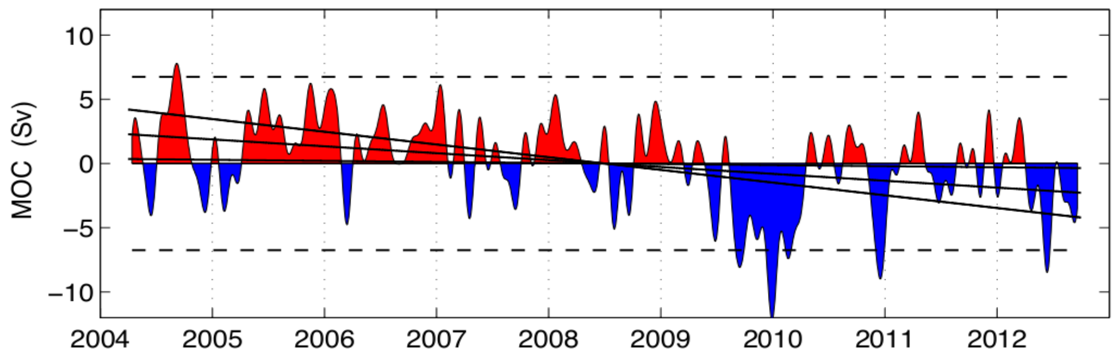


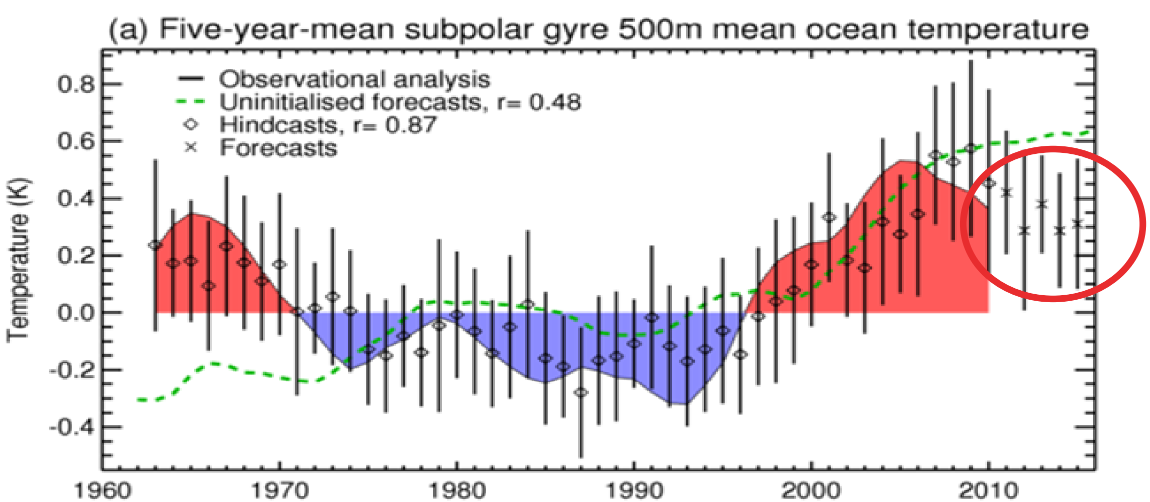
Peter J. Mumby[a,b,1], Renato Vitolo[c], and David B. Stephenson[c]

Decadal prediction

Observed Atlantic overturning circulation



Decadal forecasts of Atlantic temperature



- Atlantic predicted to cool…
- …in response to weakening of Atlantic overturning
- Likely to cause climate impacts around the Atlantic basin
- Not a reversal, but impacts associated with warm SPG less likely:
  - Cold winters and wet summers in Europe less likely
  - Fewer hurricanes than recent peaks
  - Reduced Sahel rainfall
  - Reduced risk of drought in SW USA

Smeed *et al*, 2013; Hermanson *et al* submitted

Willis Research Network

Current tropical cyclone response to climate change

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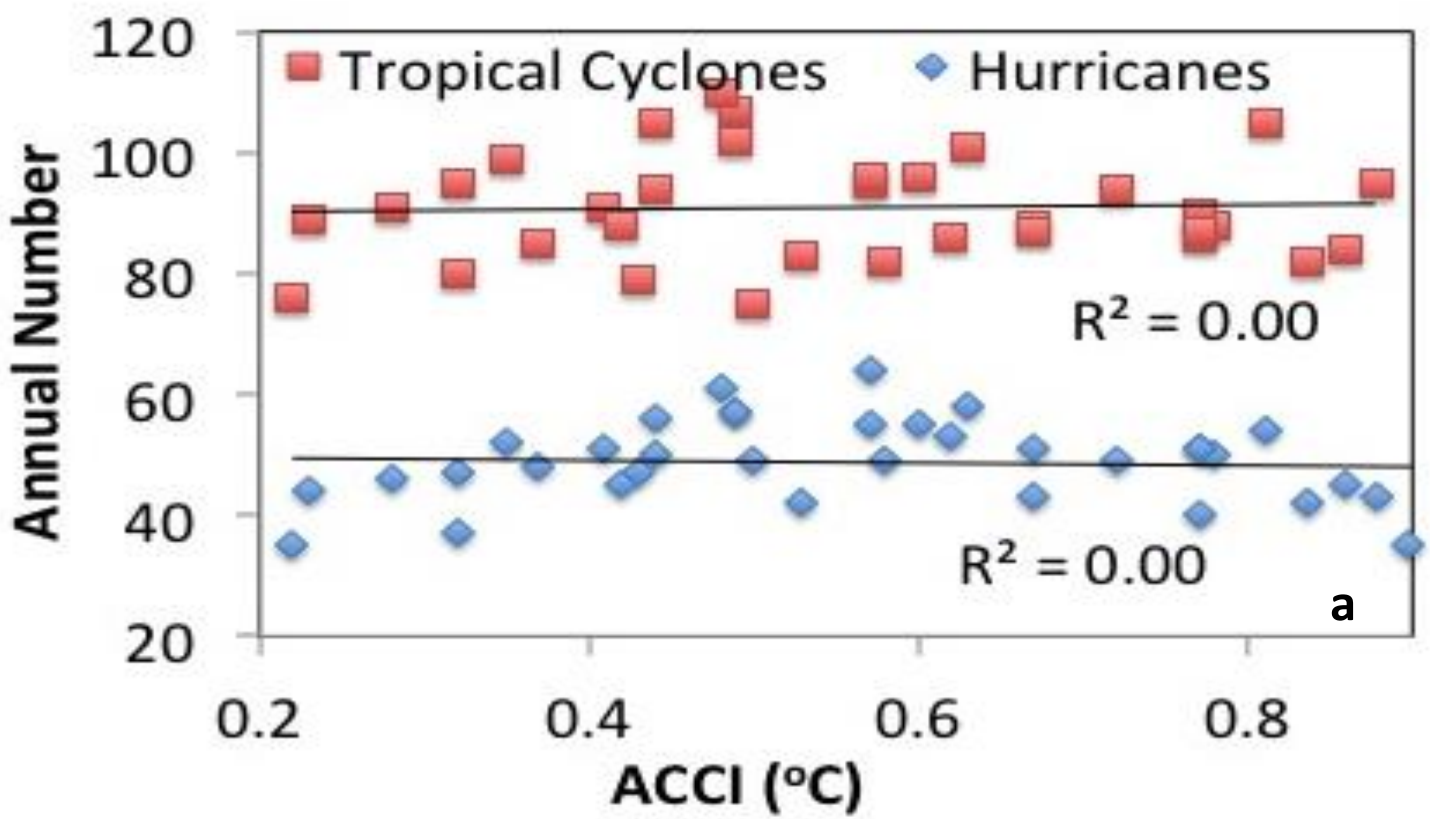
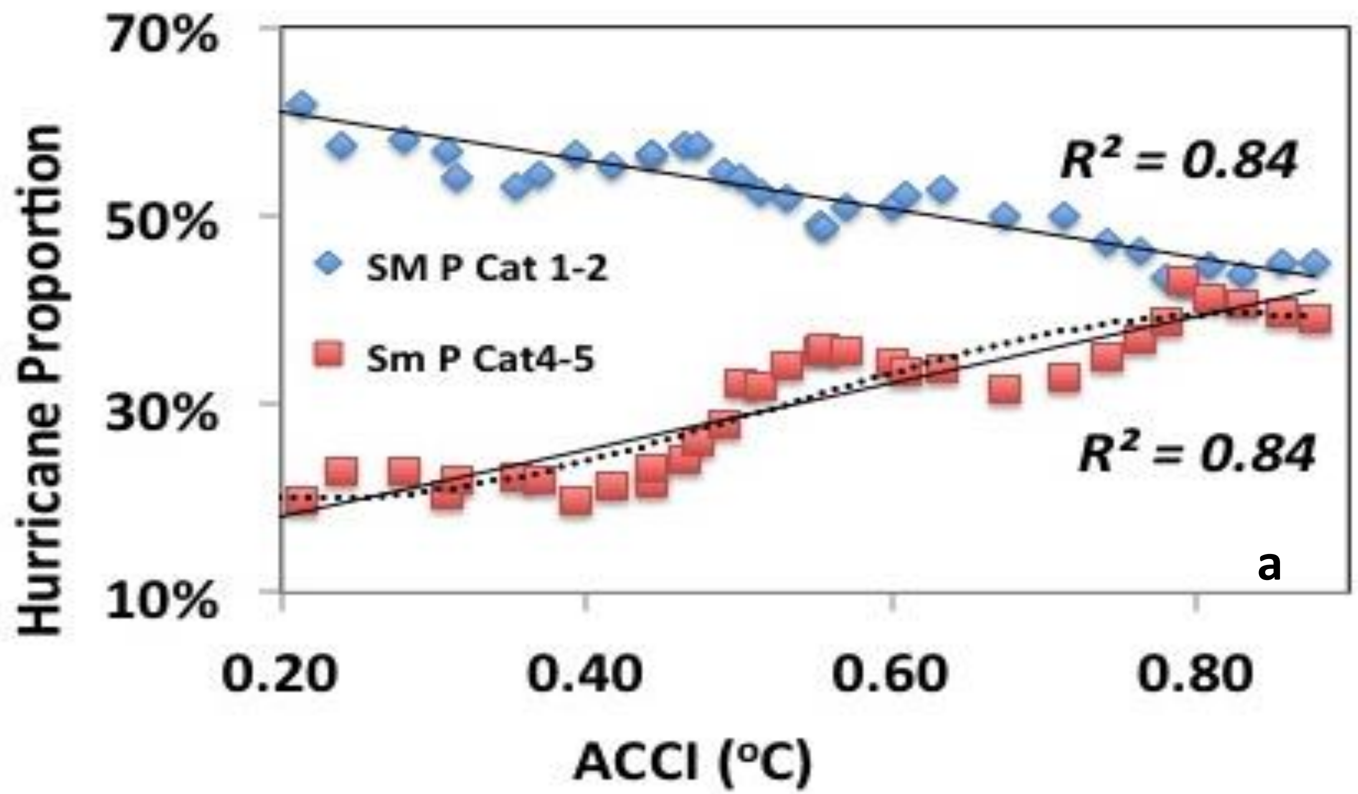


*SH Cyclones are in year season commenced

Holland and Bruyere 2013

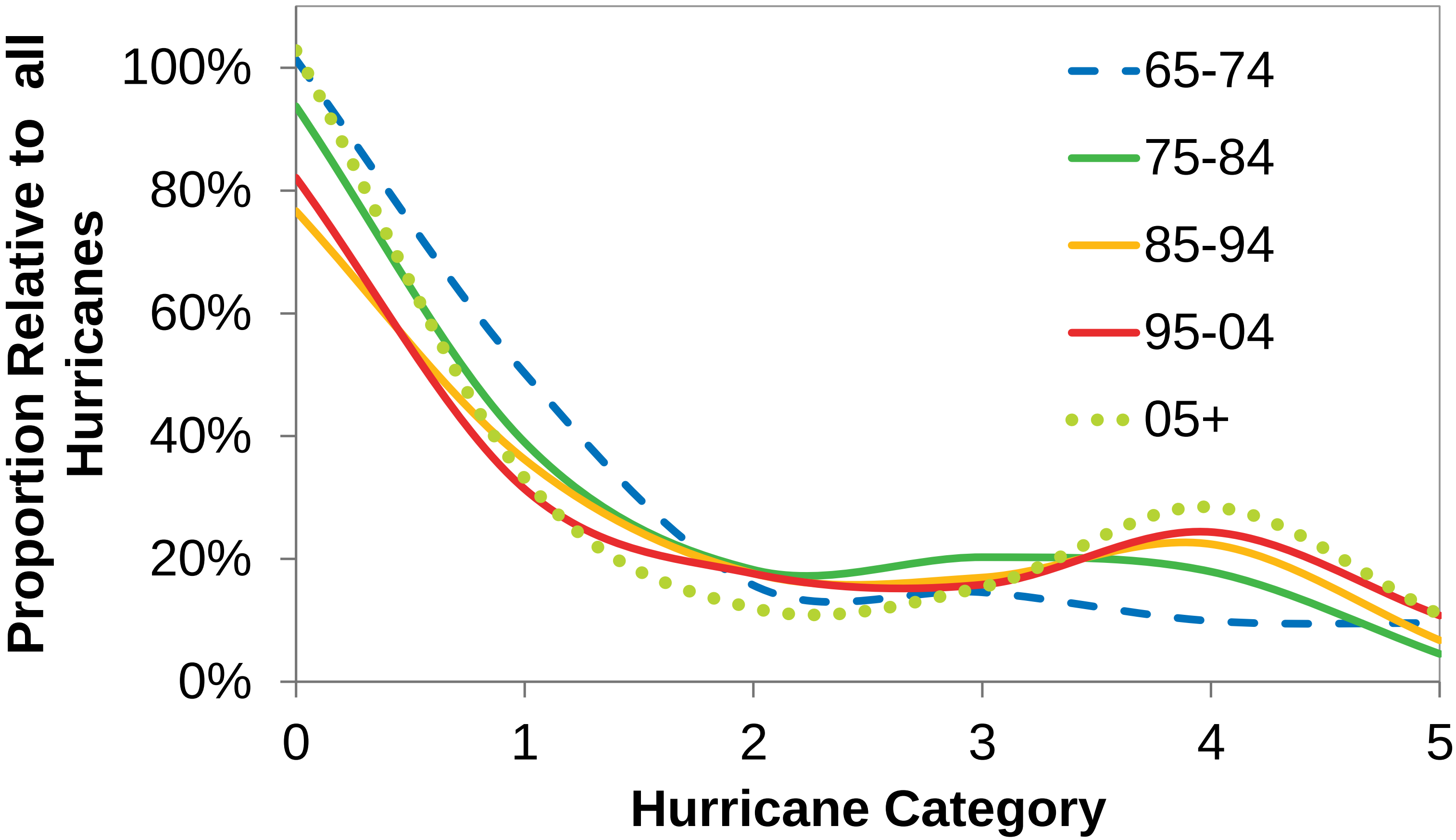
Global Intense Hurricane Response



*Data smoothed with running 5-y mean R^2 from raw data

Holland and Bruyere 2013; Also Webster et al 2005, Holland and Webster 2007, Elsner et al 2009

A bimodal intensity distribution has developed



Medium-term rates conclusions

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- If it is climate change, the rates of extreme storms are up permanently
- If it is AMO related, maybe we will start to see a fall in frequency (given Met office forecasts)
- Best practice?
  - Either way, upwards adjustment to long-term rates to reflect elevated current rates of storms seems justifiable
  - Size of adjustment needs to be weighed carefully, and models run to estimate losses for multiple possible scenarios

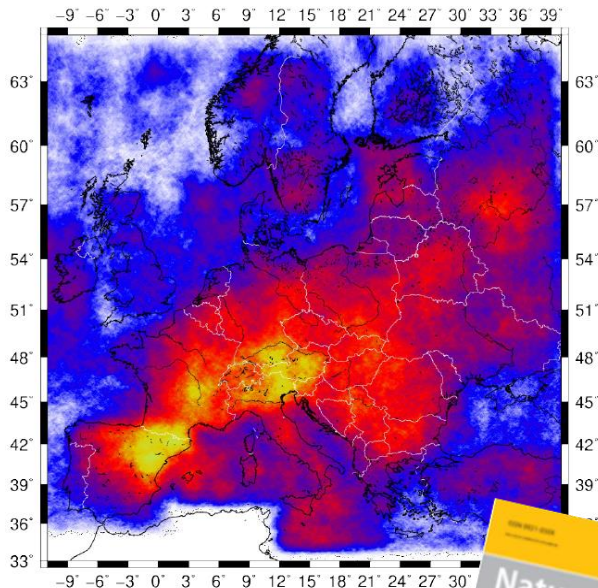
European hail context

- Last summer saw unprecedented hail losses in the German market, with three events and total losses of around $5.4B
  - Was this just a bad year? (2006 also surprised the market)
  - IPCC suggests increases in extreme precipitation are likely
  - Many market observers claim there is a trend in losses

- How do we decide?

Comparison of hail(-day) statistics

- Motor/property event set length
  - Validated to 2500 years

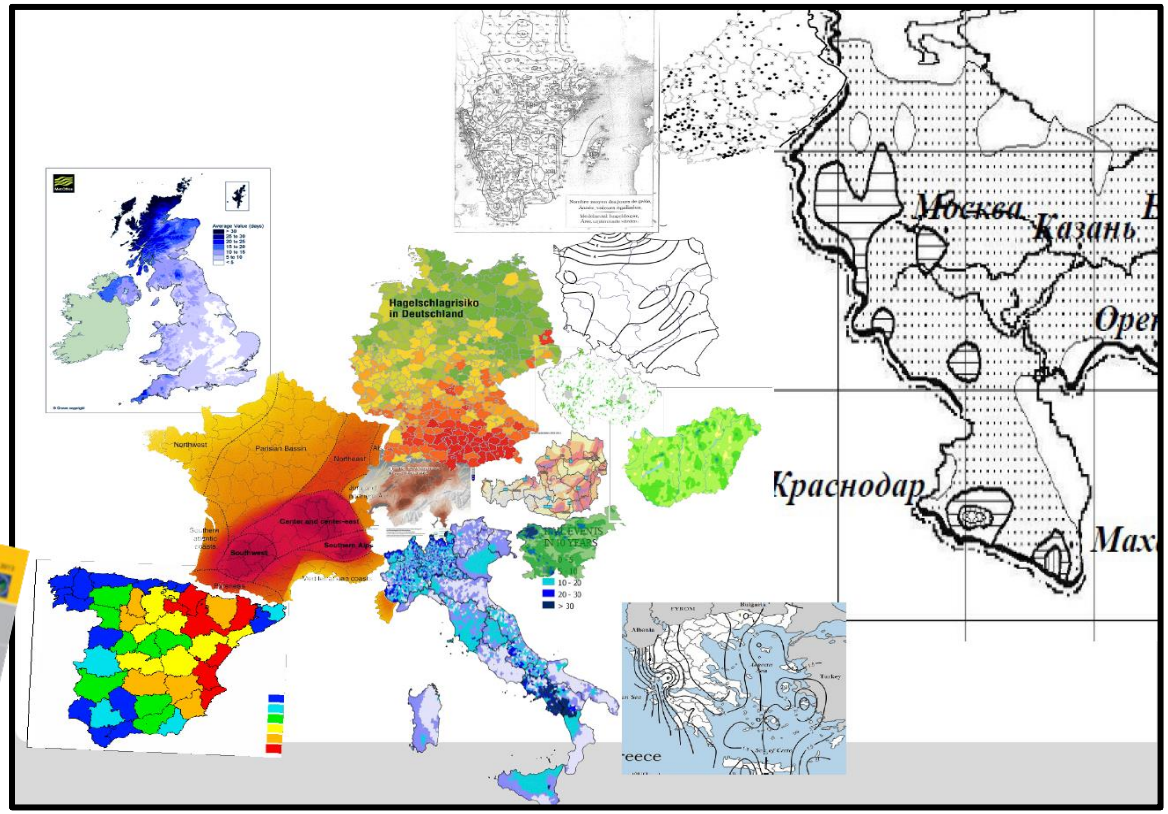


A new physically based stochastic event catalog fo
hail in Europe

H. J. Punge · K. Bedka · M. Kunz ·
A. Werner

Received: date / Accepted: date

Abstract Hailstorms represent one of the major sources of damage an loss to residential, commercial, and agricultural assets in several part Europe. However, there is little knowledge of hail risk across Europe historical damage reports due to the relative rarity of severe hail ev lack of uniform detection methods. Here we present a new stochas hailstorms for Europe. It is based on satellite observations of overs tops (OT) that indicate very strong convective updrafts and hail repor the European Severe Weather Database (ESWD). Historic hail events are defined



Comparison of hail hazard maps

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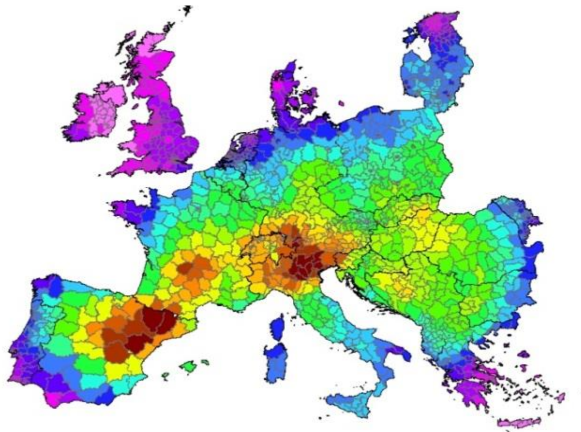
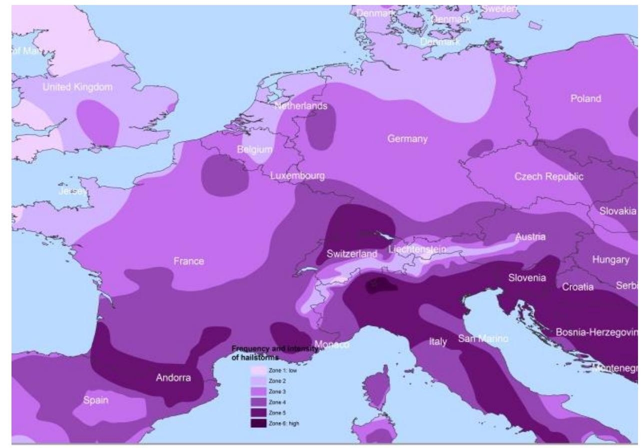
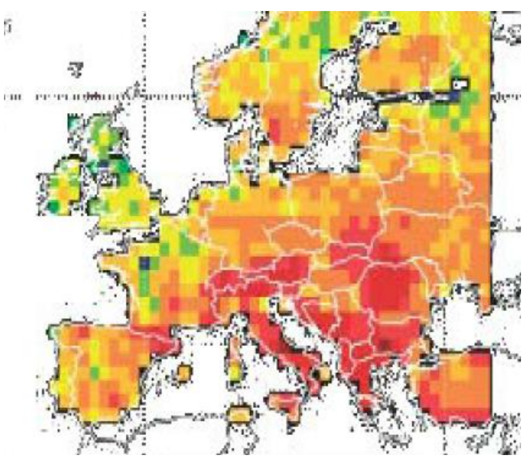
Willis EHM v3.1



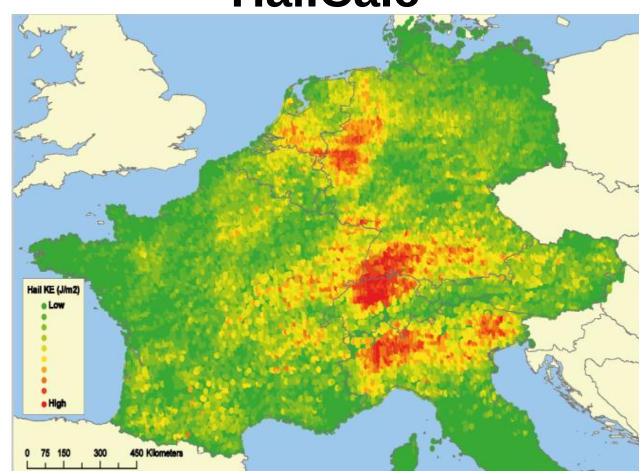
Munich Re NATHAN



Hand & Capellutti 2011



HailCalc



Hail model using Logistic regression

Logistic regression:

$$p_{\text{hail}}(x) = \frac{1}{1+e^{-g(x)}} \quad \text{mit } 0 \leq p_{\text{hail}}(x) \leq 1$$

Logistic hail model:

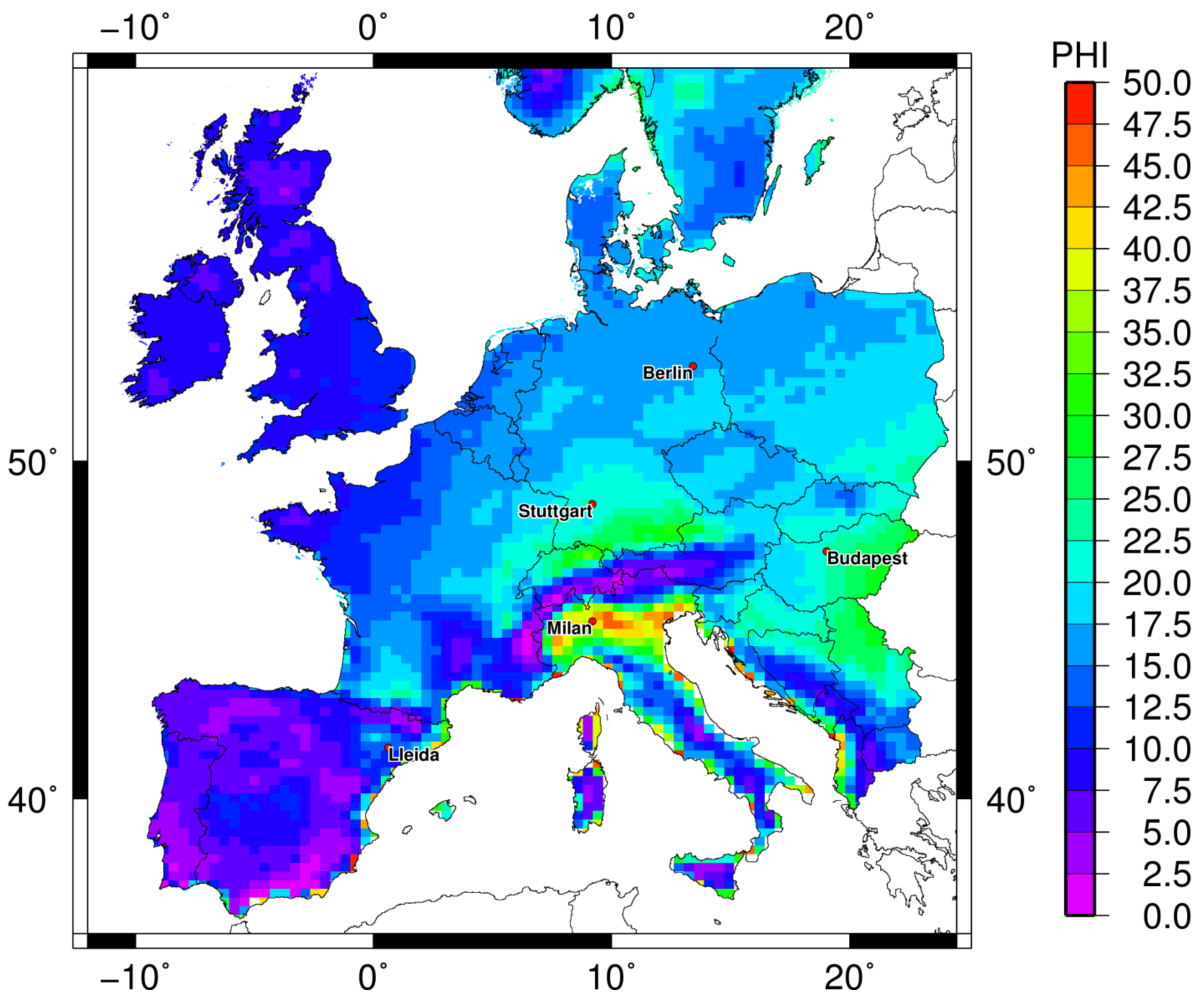
$$g_{\text{hail}} = \beta_0 + \beta_1 \cdot \text{SLI} + \beta_2 \cdot \text{T}_{\text{min}} + \\ + \beta_3 \cdot \text{T}_{2m} + \beta_4 \cdot \text{oWL}$$

$p_{\text{hail}}(x)$ ≥ 0.2 → days with hail potential

→ **Potential Hail Index (PHI)**

Climatology of PHI in Europe

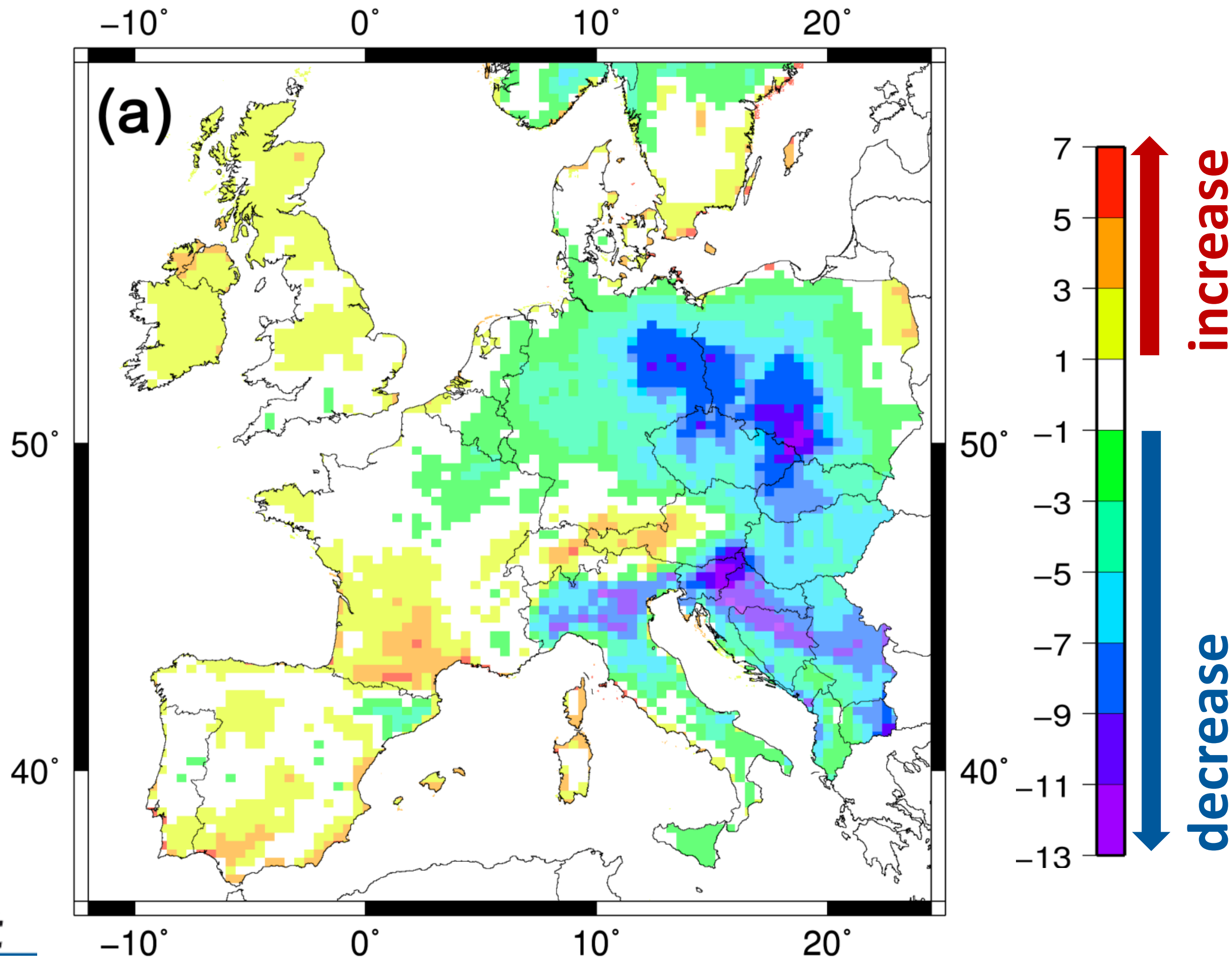
Modified logistic hail model:



Reanalysis run driven by **NCEP1** **(1951–2010)**

Mohr et al., 2014, JGR, to be submitted

Trends of PHI in Europe

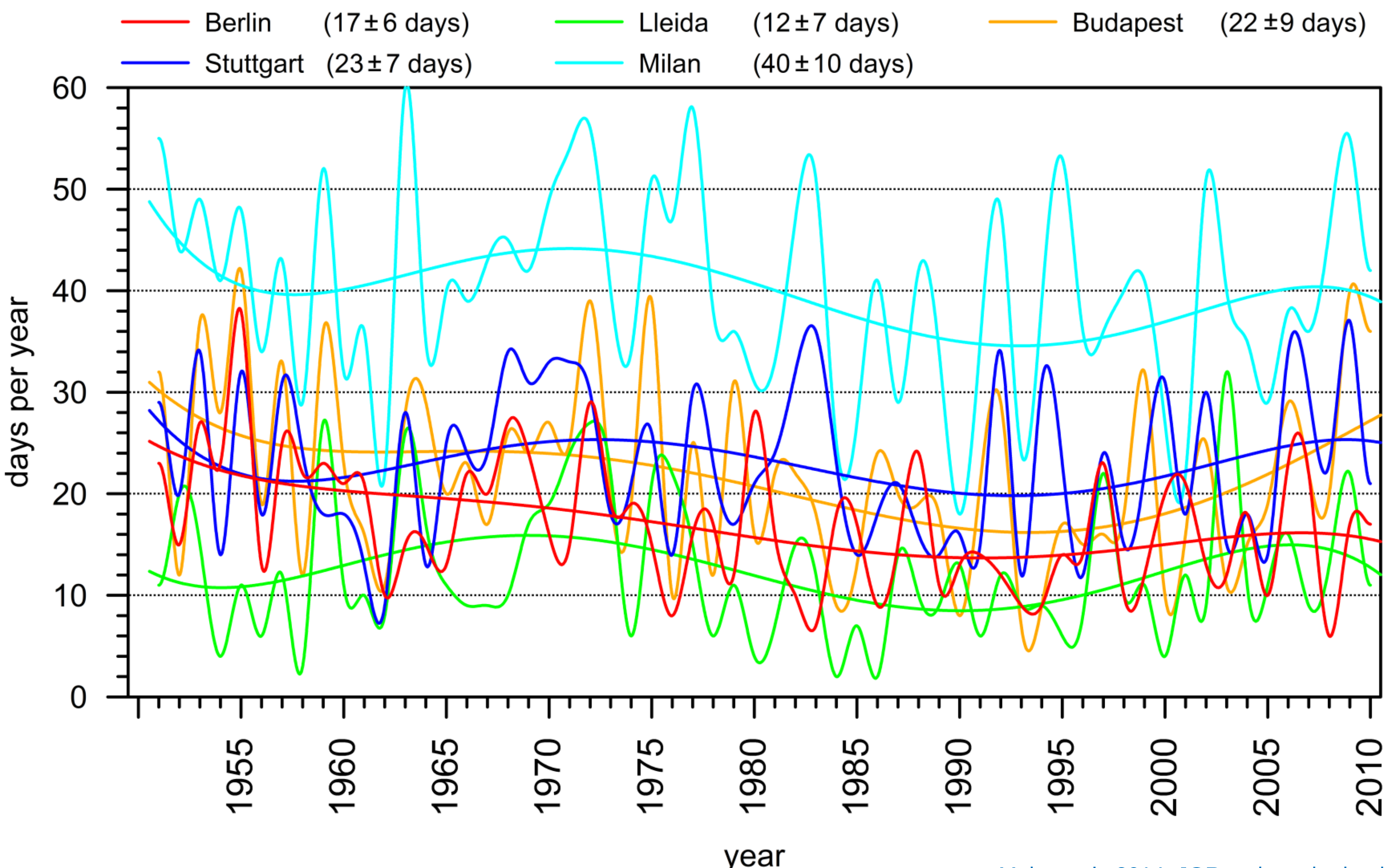


coastDat

Reanalysis run driven by **NCEP1 (1951–2010)**

Mohr et al., 2014, JGR, to be submitted

PHI variability



Mohr et al., 2014, JGR, to be submitted

European hail conclusions

- How much data is required to justify short-term adjustments?
- Willis hail model relies heavily on recent activity, and may be overestimating long-term trends

Conclusions

- Climate change and/or variability can lead to measurable changes in event rates

- Even if their origins are still debated the effects should not be ignored in modeling for risk management or pricing when deriving an "own view of risk"
  - For data-rich and model-rich perils like U.S. hurricane, it should be possible for model users to converge on an "own view of risk"
  - For perils like E.U. hail where models and data are less advanced, it may be too early to try to adjust the models for climate change

APPENDIX

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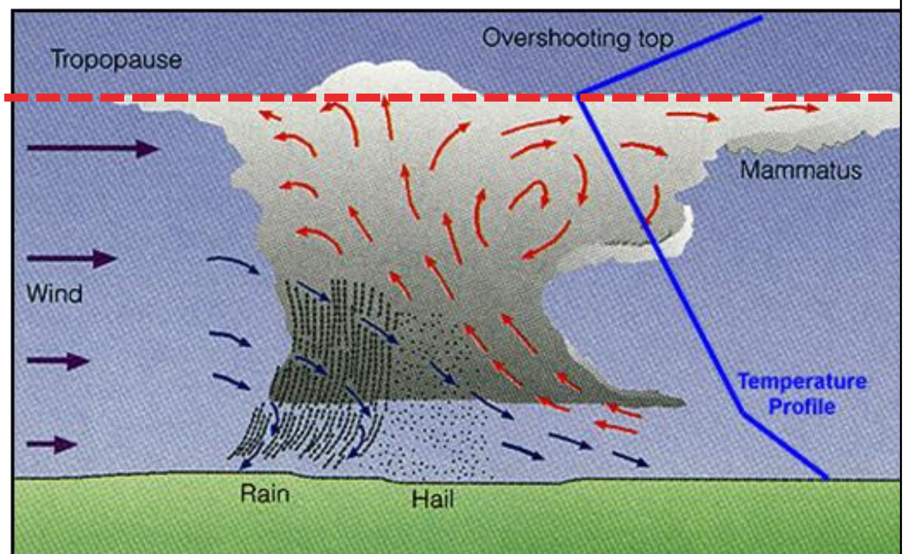
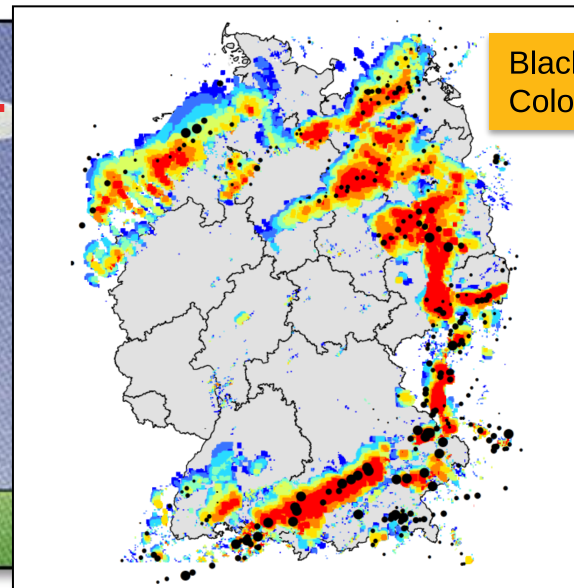
Willis European Hail Model

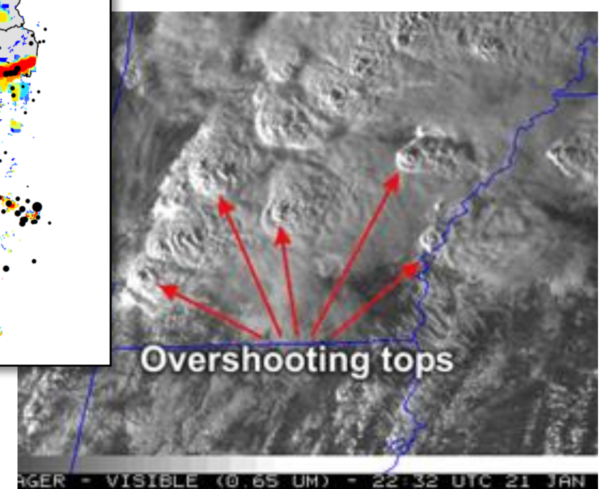
Hail modeling: overshooting tops

- Hail storms can be identified from satellite imagery using "overshooting tops"
- Provides a proxy for hazard events measured from cloud top temperatures





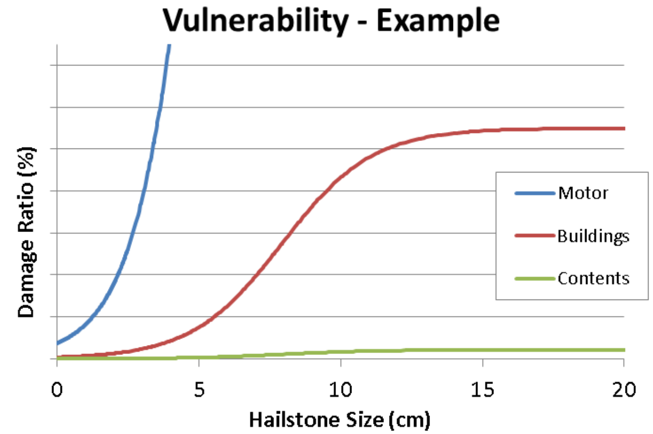
Black dots = OT
Colors = radar imagery



Hazard Identification:
- No weak, isolated OTs
- Group single detections to events
- Characterize events by ellipses

Karlsruhe Institute of Technology

Pan-European Hail Model



Historic Event Set
- Data
- Event definition
- Event frequency
- Event severity
- Event size and orientation

Stochastic Event Set
- Sample period
- Frequency distributions
- Event variable distributions
- Severity distributions
- Footprint generation

Geocode-Linkage
- Footprint translation to Disaggregation level
- Assign inventory regions

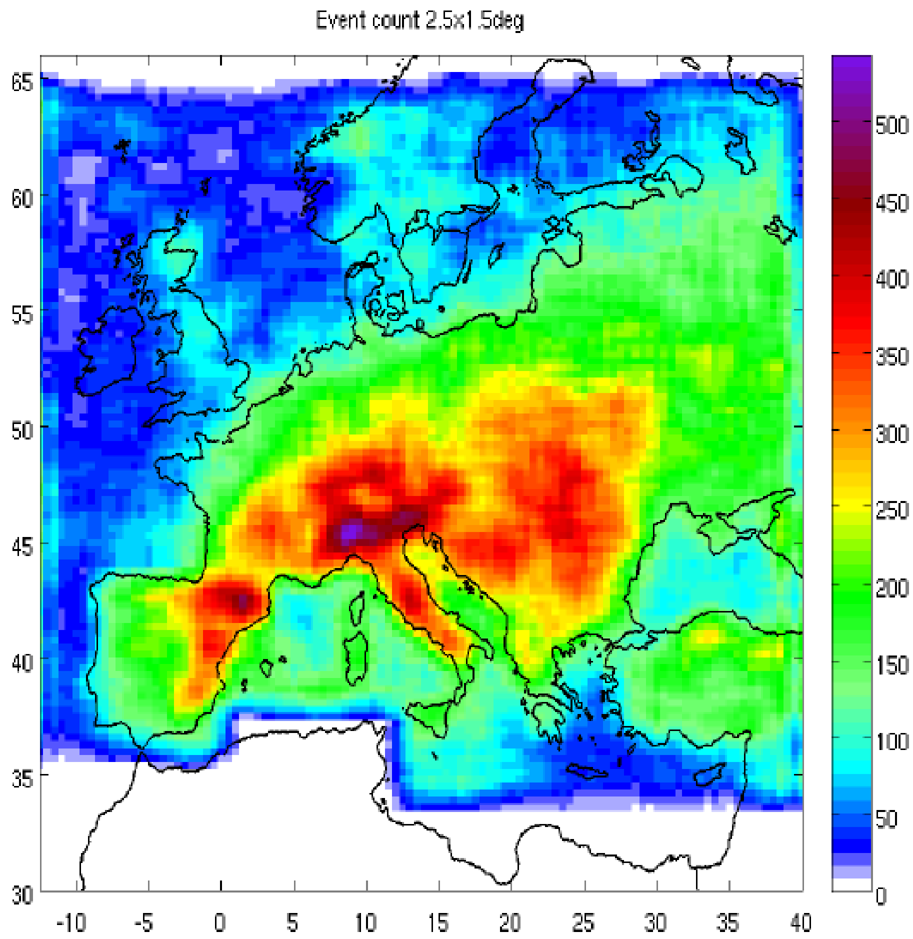
Vulnerability Model
- Country-specific
- Line of Business

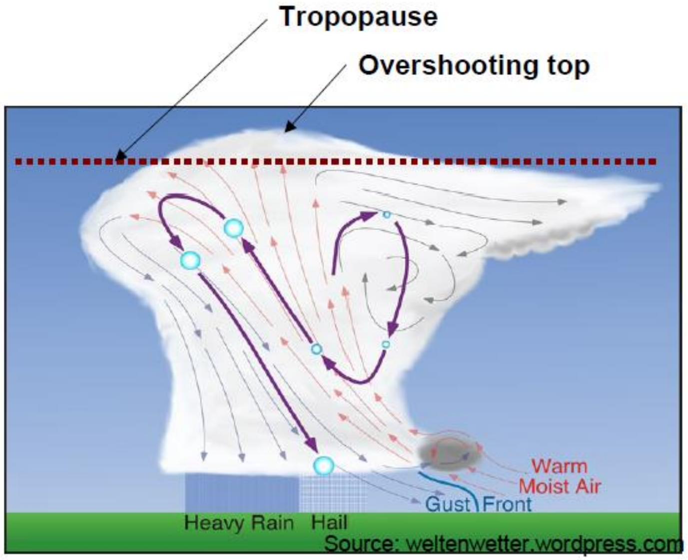
Exposure
- Country
- Exposure aggregation
- Line of Business

Financial Model
- Loss calculation
- Exceedance probabilities
- Event loss table
- Average annual loss

OT-based hail climatology

- Overshooting top as a proxy: used in the Willis hail model

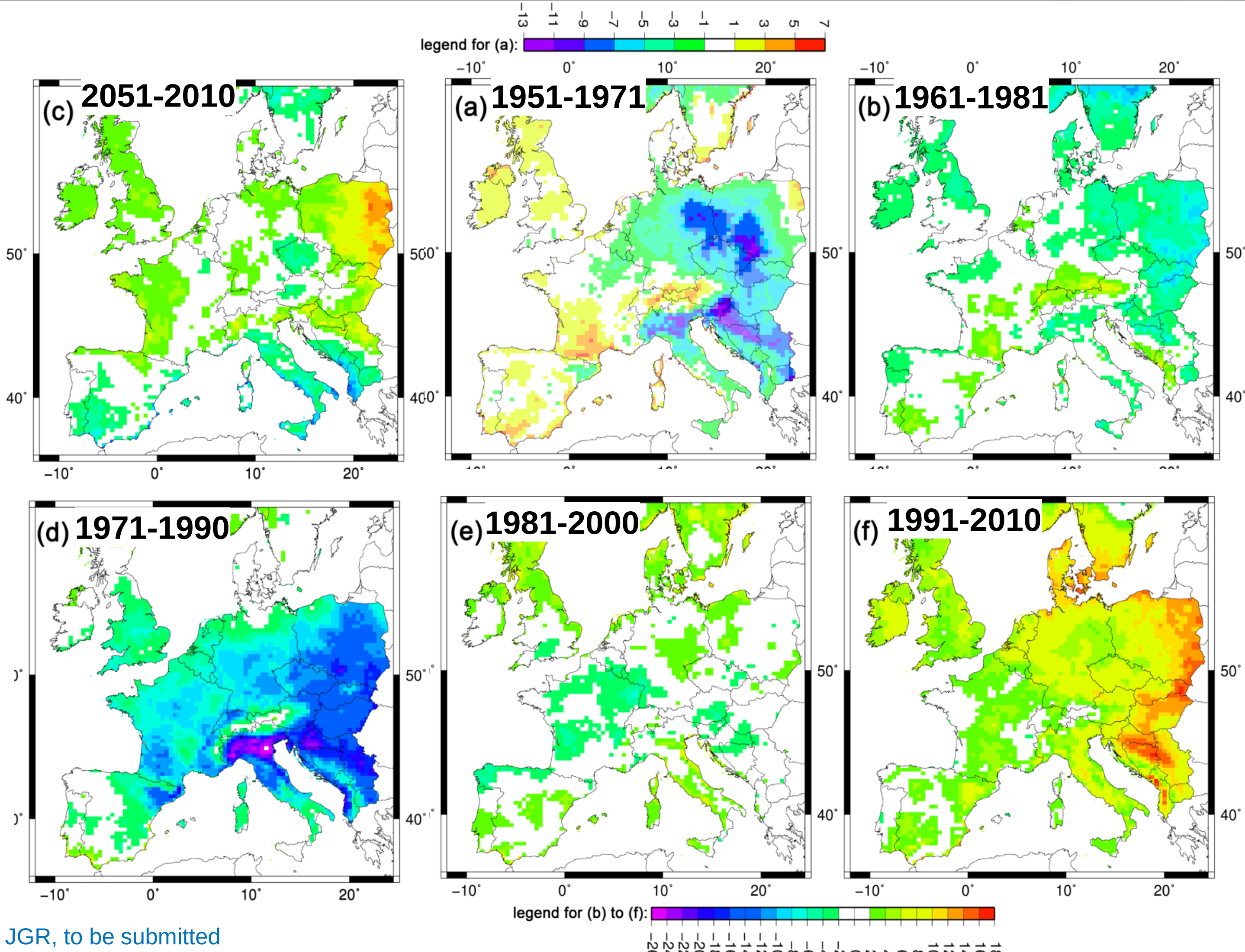




Hail

Punge et al., 2014

Trends over 20-yr periods



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