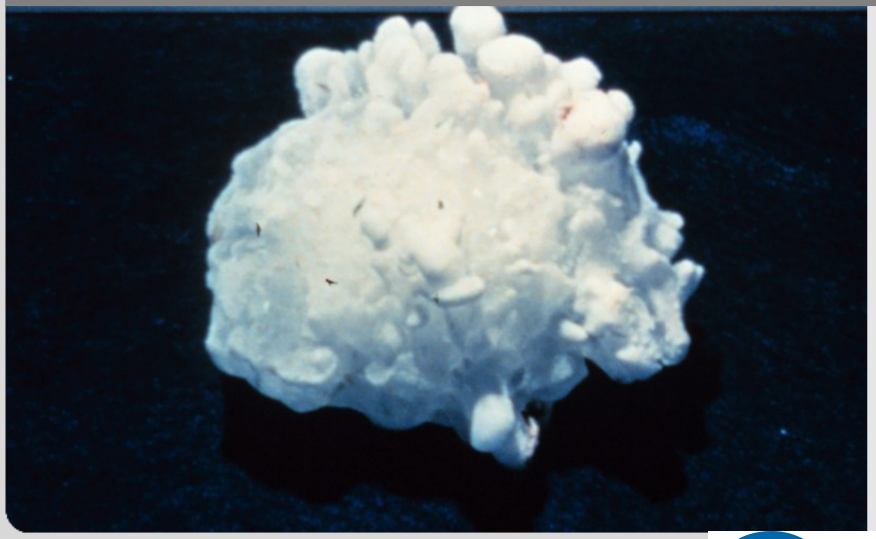
Karlsruhe Institute of Technology

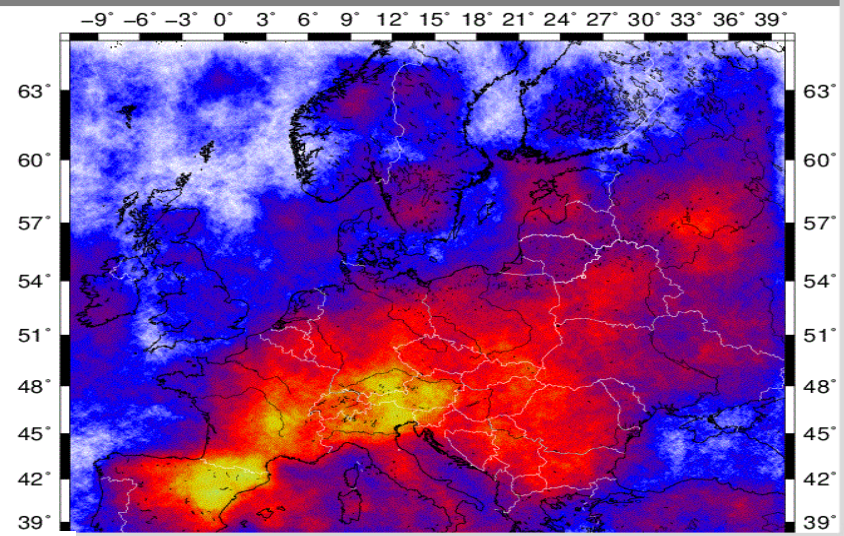
Willis Research Network

A new stochastic event catalogue for hail in Europe

HJ Punge, KIT, INSTITUTE FOR METEOROLOGY AND CLIMATE RESEARCH (IMK-TRO), WILLIS RESEARCH NETWORK;

K Bedka, SSAI; D Stephenson, U Exeter; M Kunz, KIT; M Puskeiler, KIT; A Werner, Willis Re





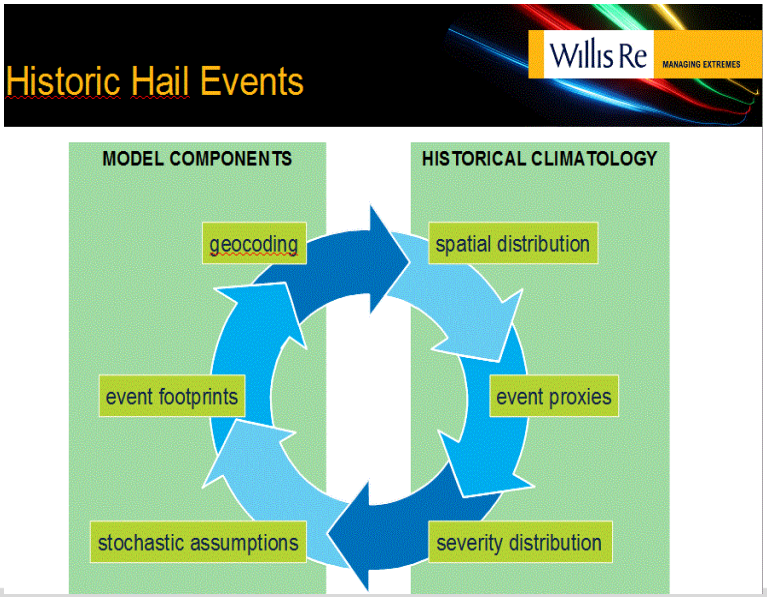
Hail risk in Europe

- Hail causes a significant part of weather-related damage in most of Europe

- Hail frequency and severity are of high interest for **insurance business, public authorities**

- Existing investigations of hail risk generally **focus on individual countries** or regions

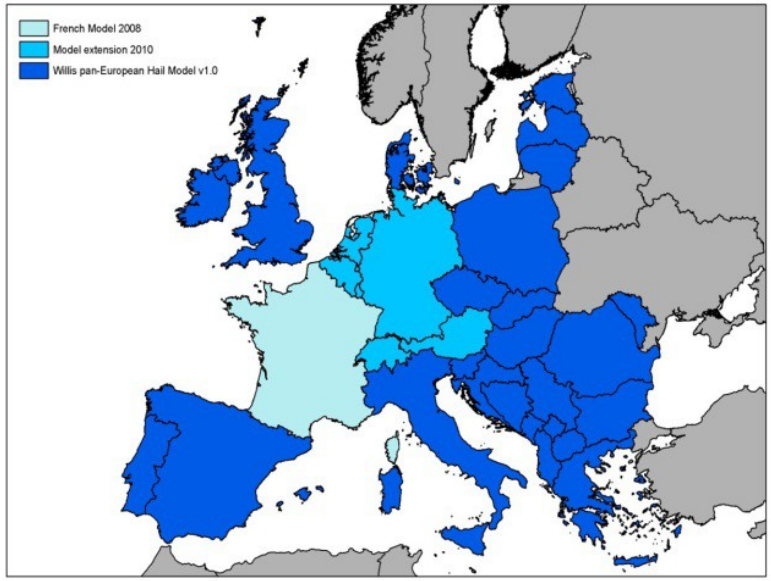
=> co-operation with insurance broker Willis
to develop Pan-European Hail model



The “Willis hail model”

Unique Hail Model for Europe

- **40 countries** explicitly modelled
- country-specific vulnerability curves
- hazard component at KIT
- damage component at Willis



Resources for hail research

- hail is **usually not covered by meteorological station network**

- point observations + damage data from insurances are most important validation data sources

- radar networks and satellite-based remote sensing can identify situations where hail is very likely.

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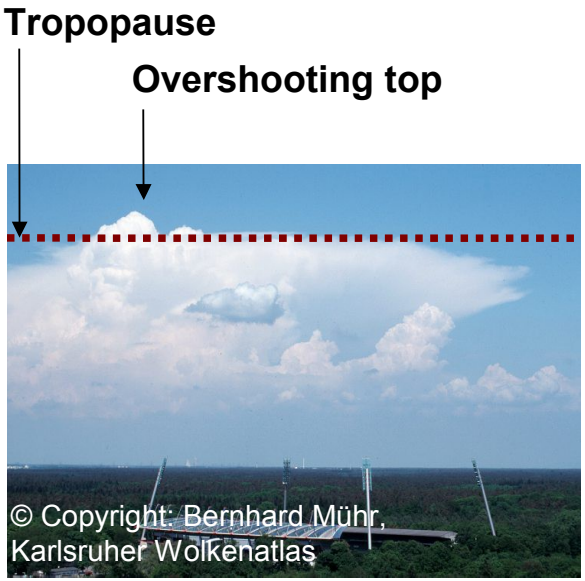
Overhooting Cloud Tops

- Hail forms in strong thunderstorms

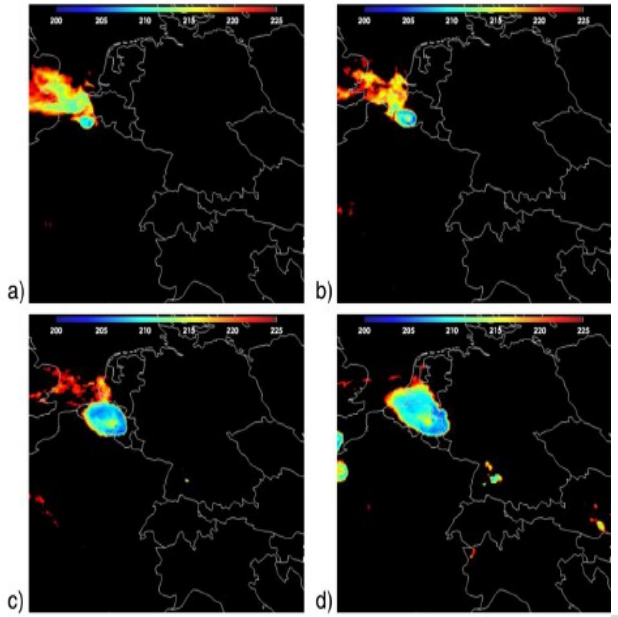
- Need strong updraught to keep hail in cloud

- Air in updraught passes beyond tropopause

- Low cloud top temperatures identified in satellite imagery

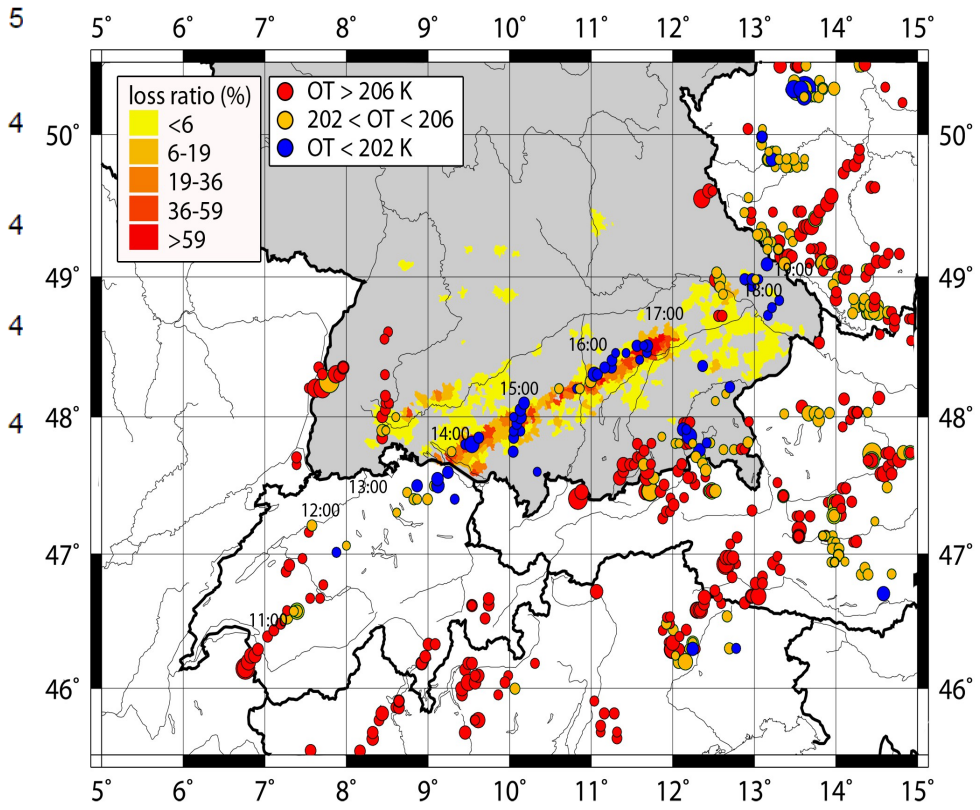


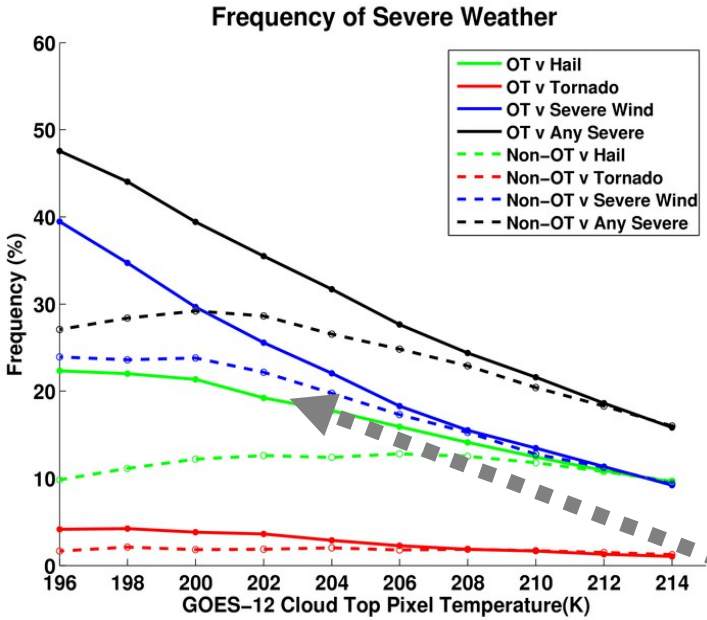
Meteosat (MSG) seviri instrument cloudtop temperatures, 25 June 2009, 10h, 11h, 12, 13h
Bedka, Atm. Res. 2011



OT occurence and hail

Loss rate for agriculture by hail and OTs on 26/05/2009





Fraction of OTs with nearby hail reports in the US (K. Bedka)

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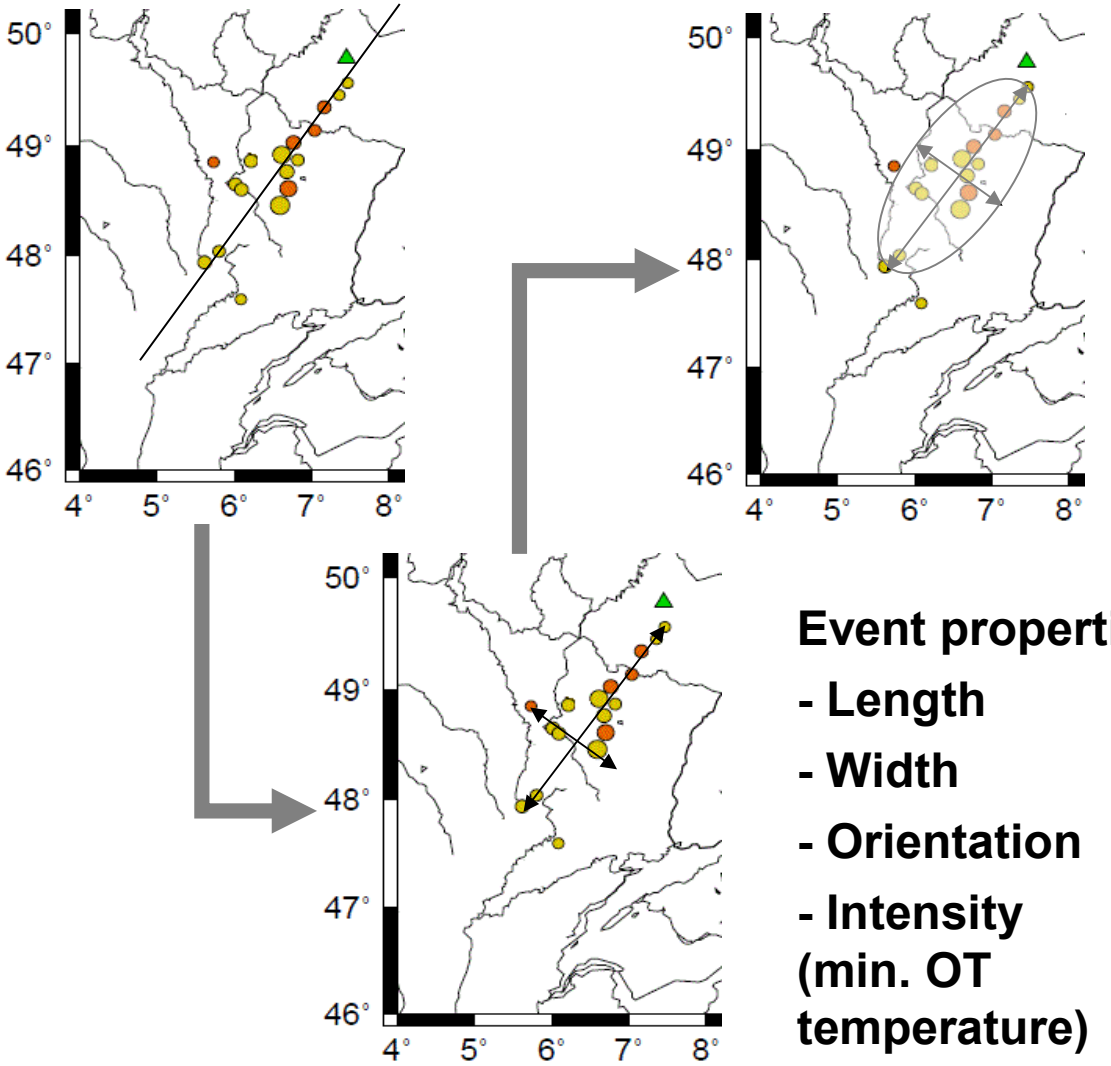
Historic events

Overshooting top data:

- from MSG SEVIRI, IRW texture brightness temperature
- **1 image / 15 minutes**
- **time & center location**
- **T_{min} & ΔT to surroundings**
- 2004 – 2011
- 30°N – 65°N, 10°W - 40°E



Event properties:

- **Length**
- **Width**
- **Orientation**
- **Intensity (min. OT temperature)**

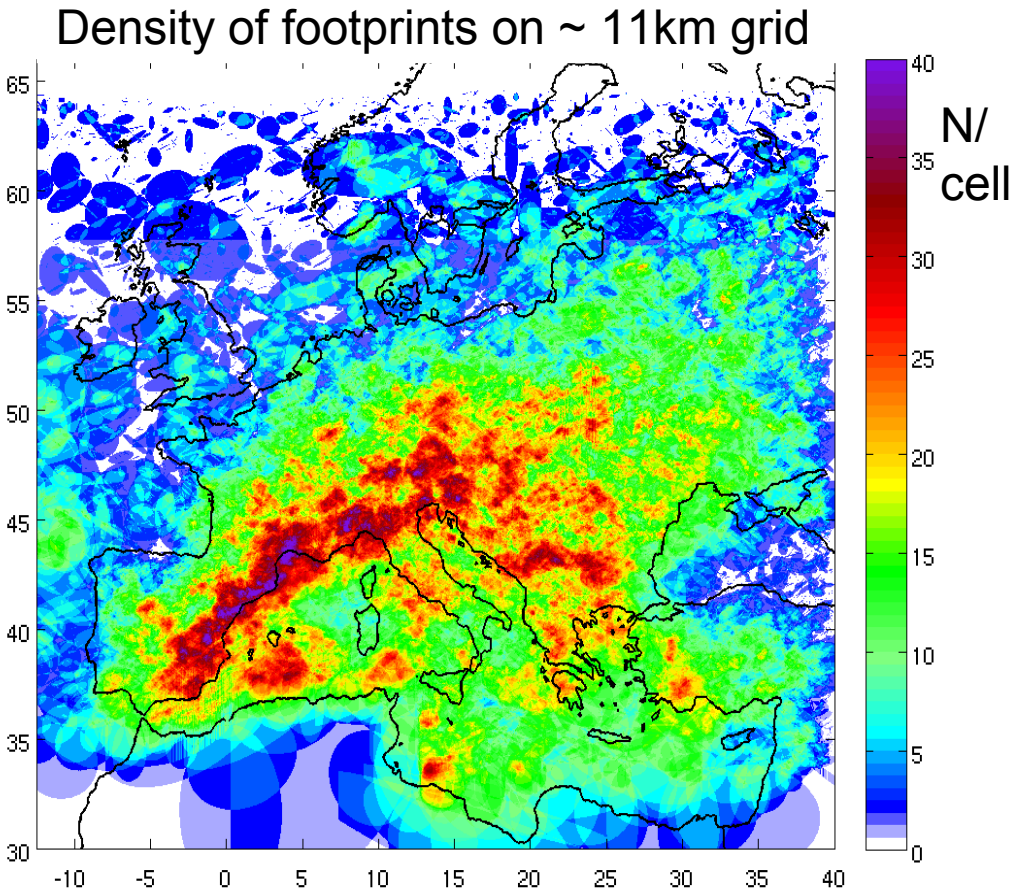
Historic event set

45599 events in 8 years

Remember: **OT events serve as a proxy** for severe convective storms

Event count is high compared to number of hail events

But: best use of available data

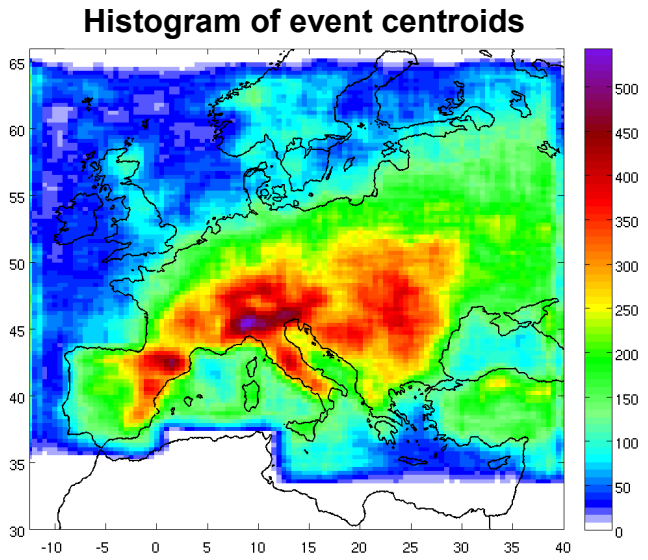


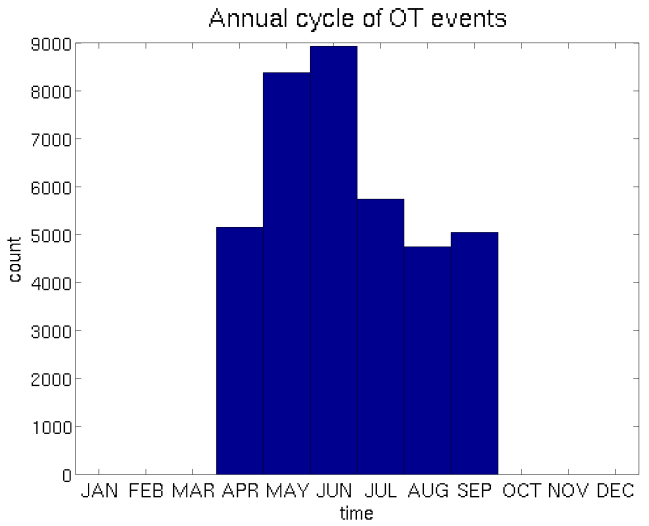
Stochastic description – frequency, monthly distribution

In the model, statistics are computed on a **2.5°x1.5° grid, rolling in steps of 0.5°**
→ account for regional variability.

Frequency: Assume **Poisson distribution.**

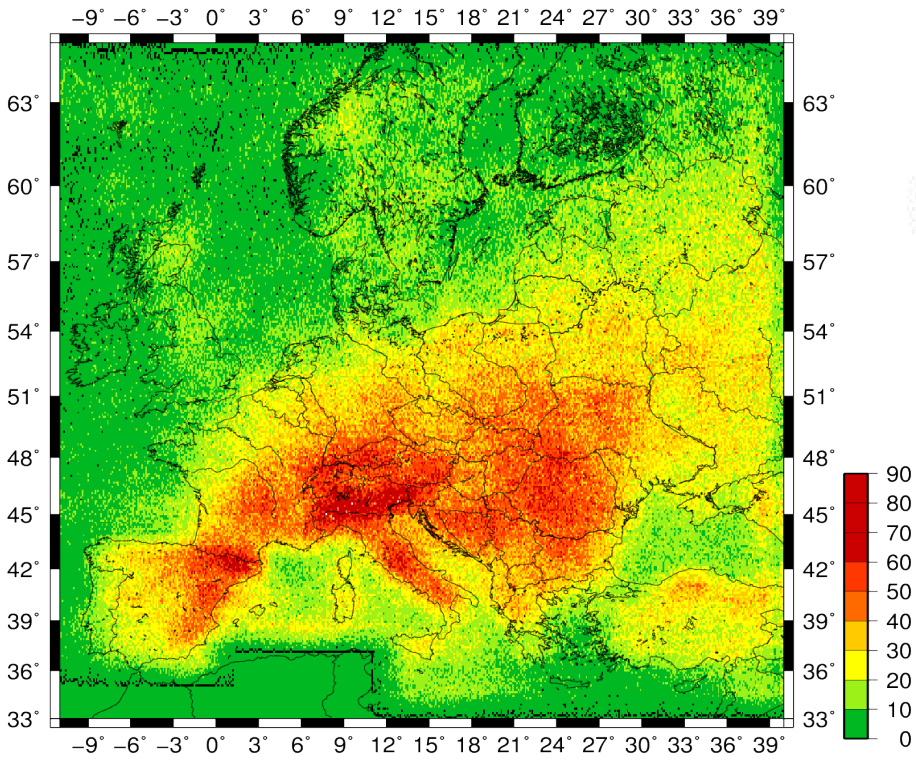
Annual cycle:
Single-mode or bimodal normal distribution



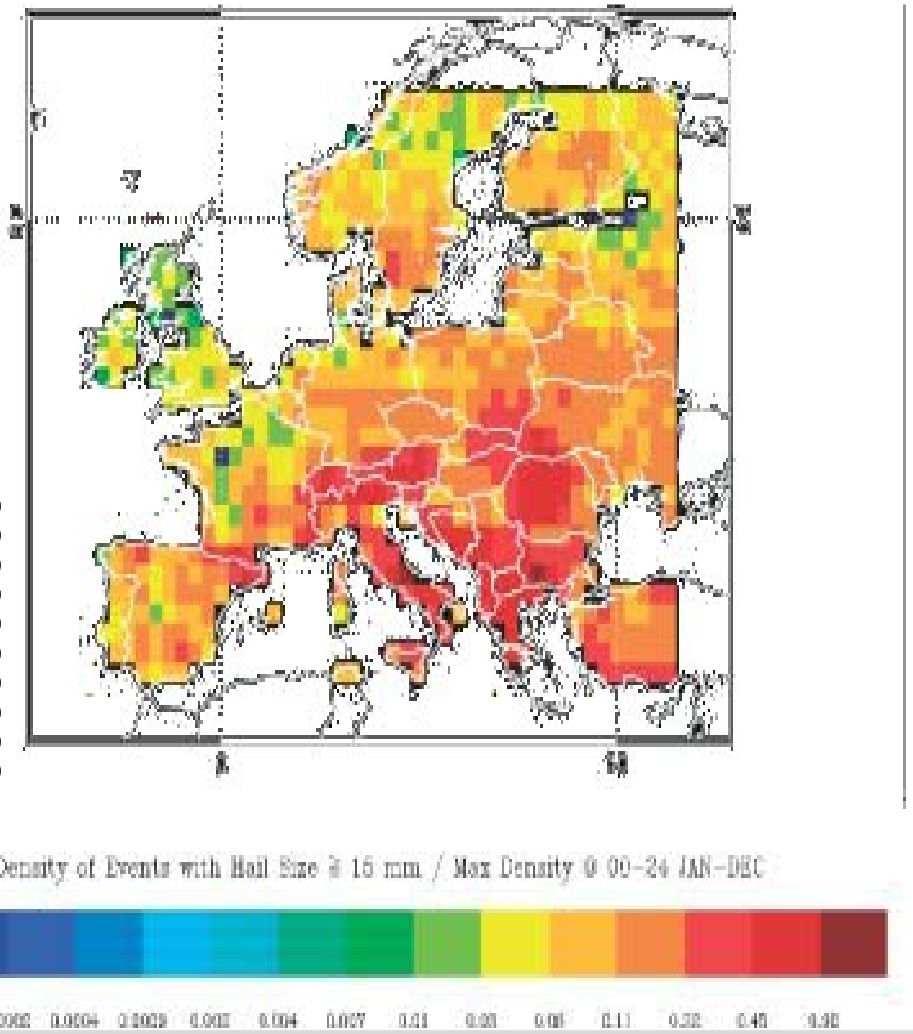


Distribution of stochastic event centroids

Event centroid density (this work)



Hail day density (Hand and Cappelutti, 2011)



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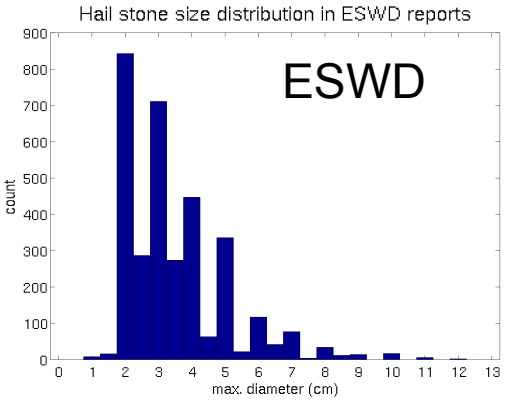
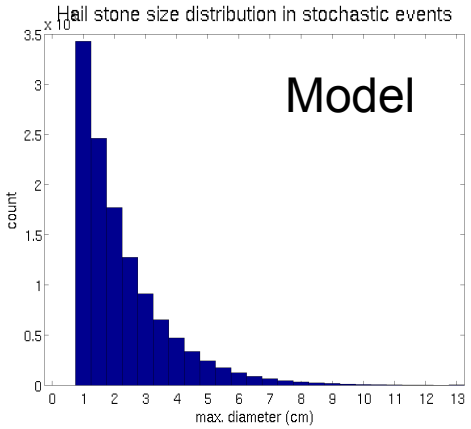
Stochastic description - intensity

Problem:
Need **hail size** as intensity measure, have OT temperature.

Solution:
1. Maximum hailstone **size distribution from ESWD**.

- apply **clustering algorithm** as for OTs
- **fit exponential distribution**
- extrapolate to small hail (d_{max} = 2.0-0.7 cm)





2. Use **correlation Tmin – length – width** in random

Correlation of event properties	Width	Min. temperature / Max. hail size
Length	0.83	0.37
Min. temperature/ Max. hail size	0.34	

Stochastic event set

- **N = 1.05 10^6** random events
- 3 correlated sets of random numbers (length-width-intensity)
- random numbers for orientation and month

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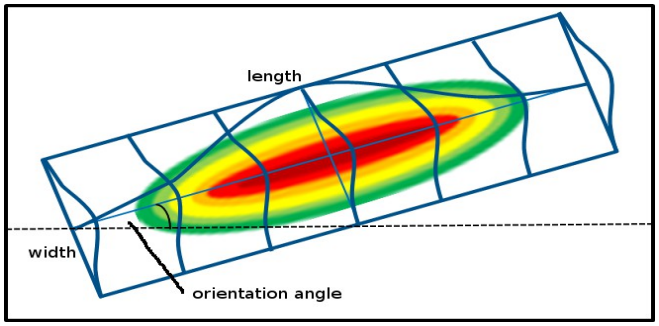
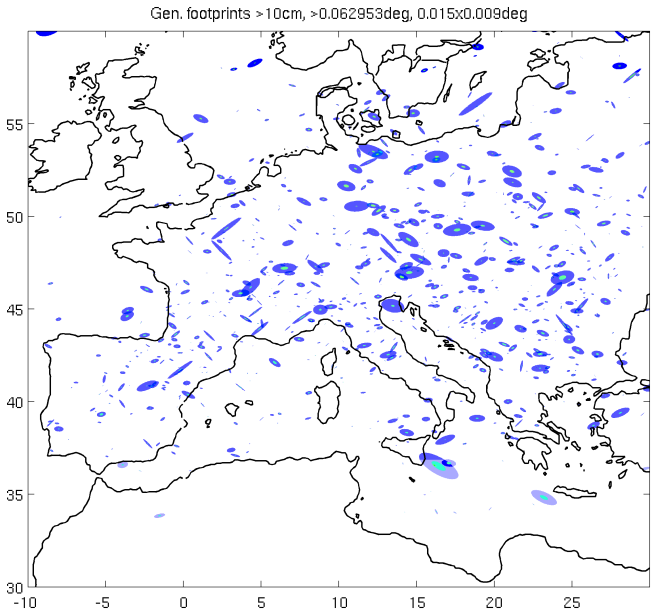
Footprint construction

- **Hailstone size d** is a function of position vs event centre
- max. hail size **d_{max} in the center**
- Resolution **0.1°**
- Retain points with **d > 0.7 cm**



Example: Hail events with d_{max}>10cm



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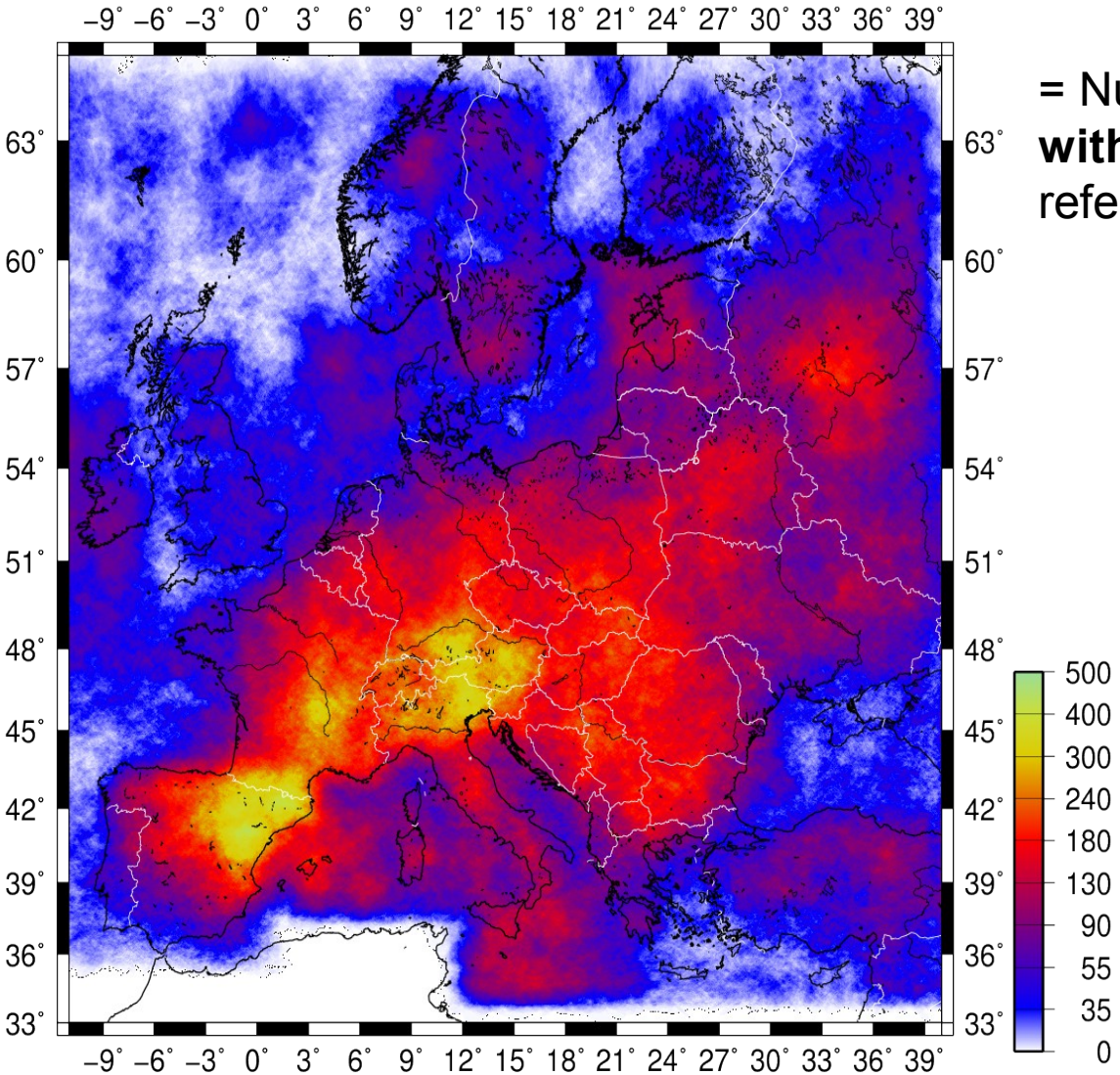
Stochastic event footprint density



= Number of **hail occurrences within 11km x 11km** box, over reference period (to be defined)

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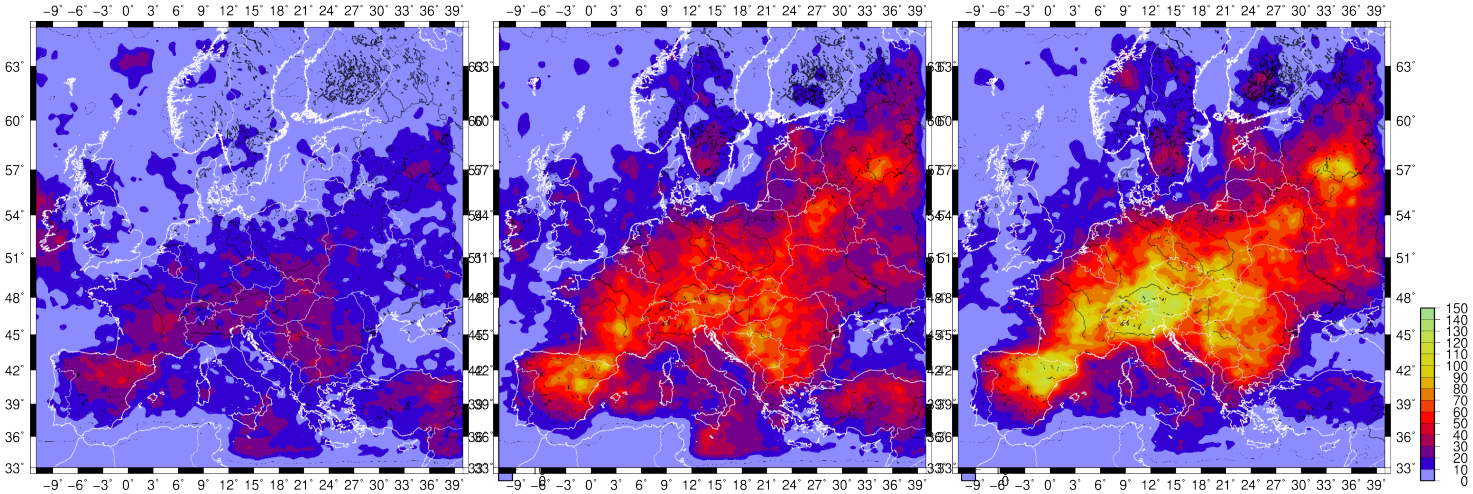
The hail season



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