



Changes of the Thunderstorm and Hail Potential in Climate Change

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Project: HARIS-CC "Hail Risk and Climate Change"

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Motivation



Problem: Hail is a local-scale phenomenon

- Lack of suitable monitoring systems
- No longer time series available (≥ 30 years)

Low number of direct observations ≠ statistical analyses

"Convective parameters show an increase in the thunderstorm potential over the last 30 years in Central Europe." (Mohr and Kunz, 6th ECSS, Palma de Mallorca, 2011)



(Mohr and Kunz, 2013a)

Scientific questions and objectives?

1. Which meteorological parameters describe hail events at best?

e.g., CAPE, Lifted Index (LI) (see Kunz, NHESS 2007; Mohr and Kunz, Atmo. Re. 2013a)

- 2. How can the diagnostics of hail events be improved by multivariate statistics?
- **3.** Climatology and trends in hail potential in Germany and Europe?
- 4. What changes of the hail potential can be expected in the future?



Data sets

- Regional Climate Models (RCMs) Data with high resolution about 10 – 20km
 - Reanalysis runs:
 - 1. Germany: Driven with reanalysis data ERA40
 - 2. Europe: Driven by reanalysis data NCEP-NCAR 1
 - Ensemble with seven regional climate runs that differ by:
 - 1. Versions of the RCM COSMO--CLM (versions 3.1 and 4.8)
 - 2. Global climate data (ECHAM5 Run1–3)
 - 3. Emission scenario (A1B, B1)
- Building insurance data of SV SparkassenVersicherung AG:
 - Baden–Wuerttemberg (Southwest of Germany)
 - adjusted for lightning data, inflation and corrected due to portfolio





Hail model by means of logistic regression



2. How can the diagnostic of hail events be improved by multivariate statistics?

Logistic regression:

$$p_{\text{hail}}(x) = \frac{1}{1 + e^{-g(x)}} \text{ with } 0 \le p_{\text{hail}}(x) \le 1$$

Logistic Hail Model: $g_{hail} = \beta_0 + \beta_1 \cdot SLI + \beta_2 \cdot T_{min} + \beta_3 \cdot T_{2m} + \beta_4 \cdot oWL$

$$p_{\text{hail}}(x) \ge 0.4 \longrightarrow \text{day with hail}$$

Climatology & trends of PHI



3. Climatology and trends in hail potential in Germany?



Climatology of PHI



3. Climatology of PHI in Europe?



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PHI in the future



4. What changes can be expected in the future (2021-2050 to 1971-2000)?



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PHI in the future



4. What changes of the hail potential can be expected in the future?



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Conclusions



- Improvement of diagnostics of hail events using a specified logistic hail model.
 - 🔶 Potenial Hail Index (PHI)

However:

Trigger mechanism of convection (like flux convergence due to orography) not considered.

- Climatology of PHI shows a north-to-south gradient over Germany and a positive trend between 1971–2000.
- Modified version of the logistic hail model confirms hail relevant regions in Europe (known from literature).
- Ensemble of seven RCMs: positive changes (ca. 22 42%) of the hail potential in the future in Germany (2021–2050 to 1971–2000).



Thanks for your attention! Questions?

Mohr, S. and M. Kunz, 2013a:

Changes in the Hail Potential Over Past and Future Decades – Identification Using a Logistic Hail Model. J. Geophys. (submitted).

Mohr, S. and M. Kunz, 2013b:

Trend analysis of convective indices relevant for hail events in Germany. *Atmos. Res.* 123, 211–228.

Kunz, M., 2007:

The skill of convective parameters and indices to predict isolated and severe thunderstorms. Nat. Hazards Earth Syst. Sci. 7, 327–342.

Trends of PHI



3. Trends of PHI in Europe?

