Karlsruhe Institute of Technology

What data can best predict hail damage?

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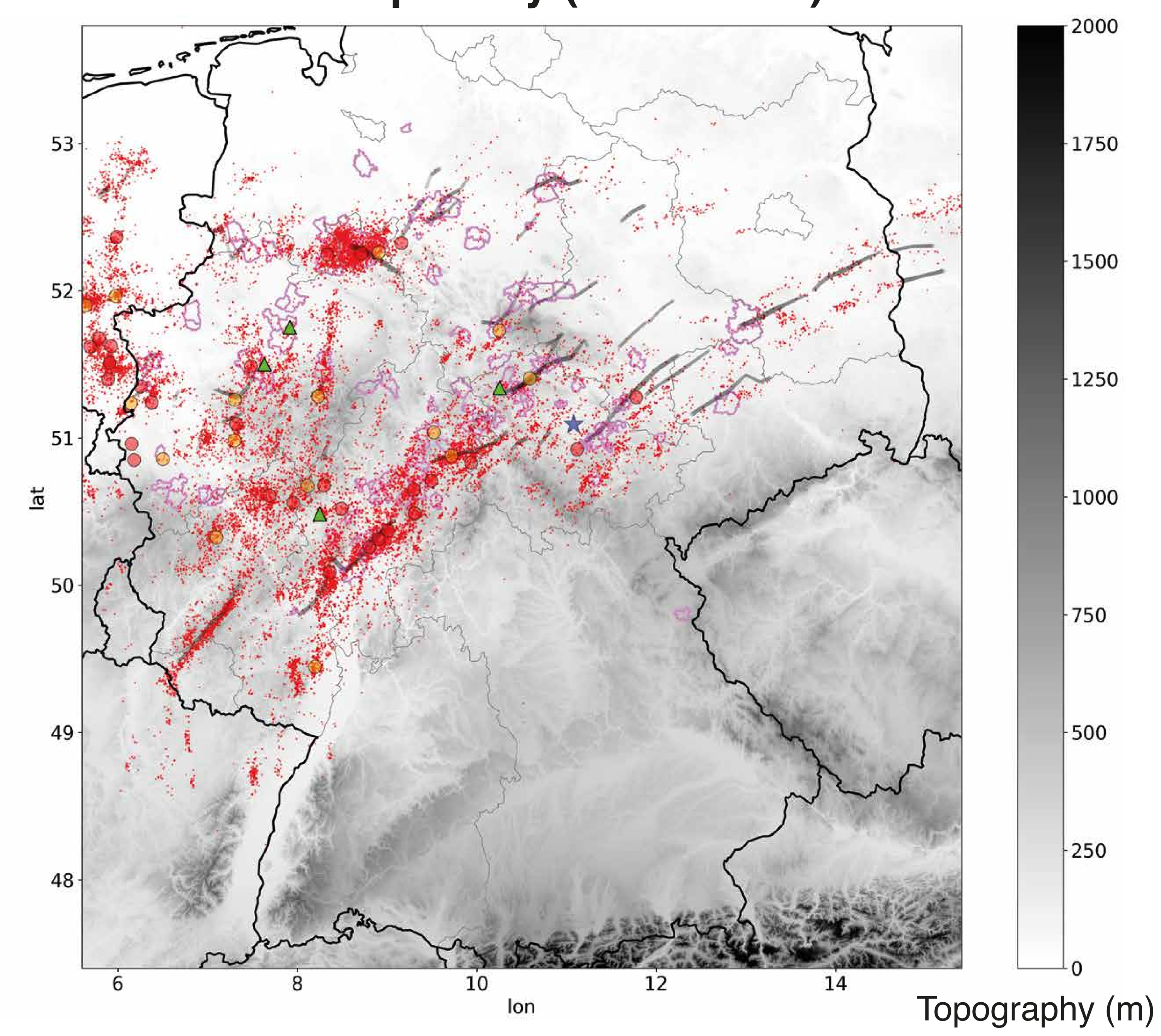
Various **proxies** can be used to estimate hail at the ground. Which of them have skill when tested against **crop damage claims**?

Data

- Lightning detections [1]
- Hail observations (ESWD) [2]
- Satellite Overshooting Top Detections [3]
- Maximum radar reflectivity [4]
- Radar derived hail tracks [5]
- Satellite passive microwave hail detections [6]

Example day (07/10/2014)



Agricultural insurance claims over Germany

yes/no hail damage per community per day

Dataset: **93 days** in summer (MJJA) 2014, including null cases

Skill analysis

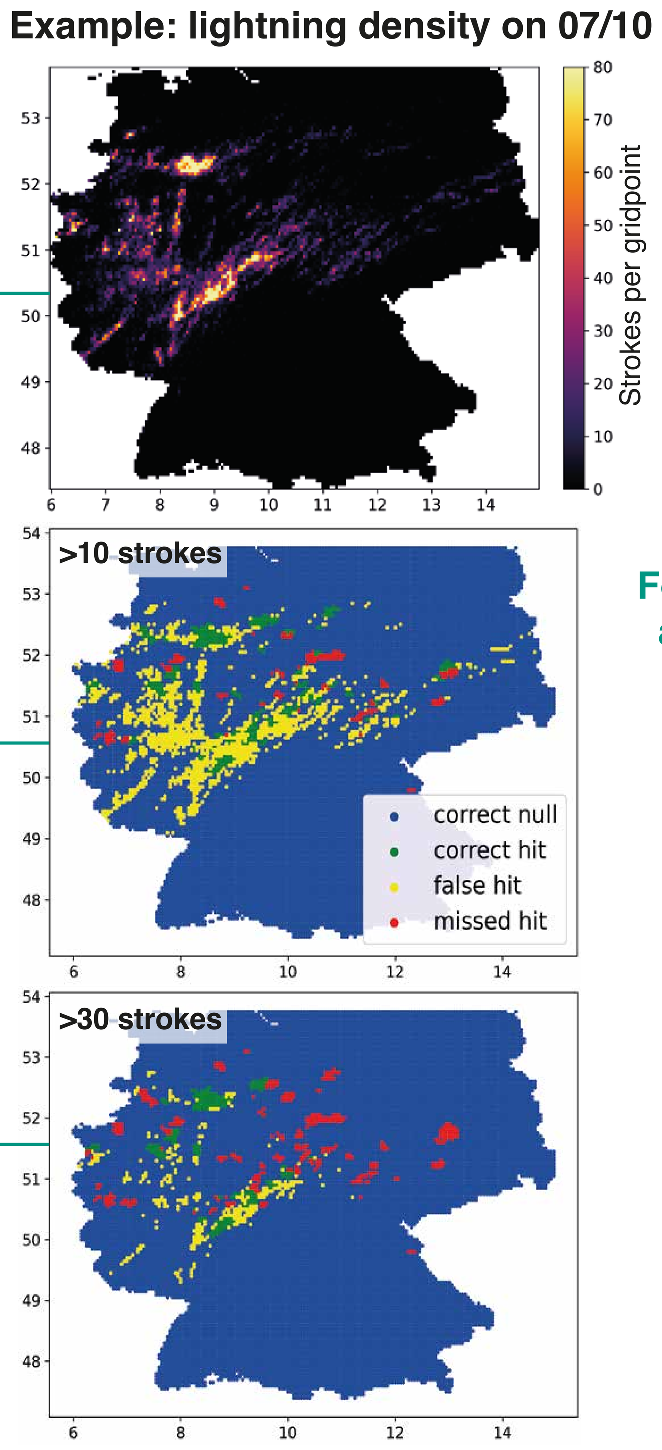
All data is brought on the same 0.05° grid for each day (e.g., lightning strokes per grid point)

For each gridpoint, yes/no hail is predicted based on a threshold (e.g., 10 lightning strokes per gridpoint)

...then compared to damage claims (and ESWD reports) to get the four categories of the contingency table (e.g., correct hits in green) from which categorical skill metrics can be calculated (POD, FAR, HSS)

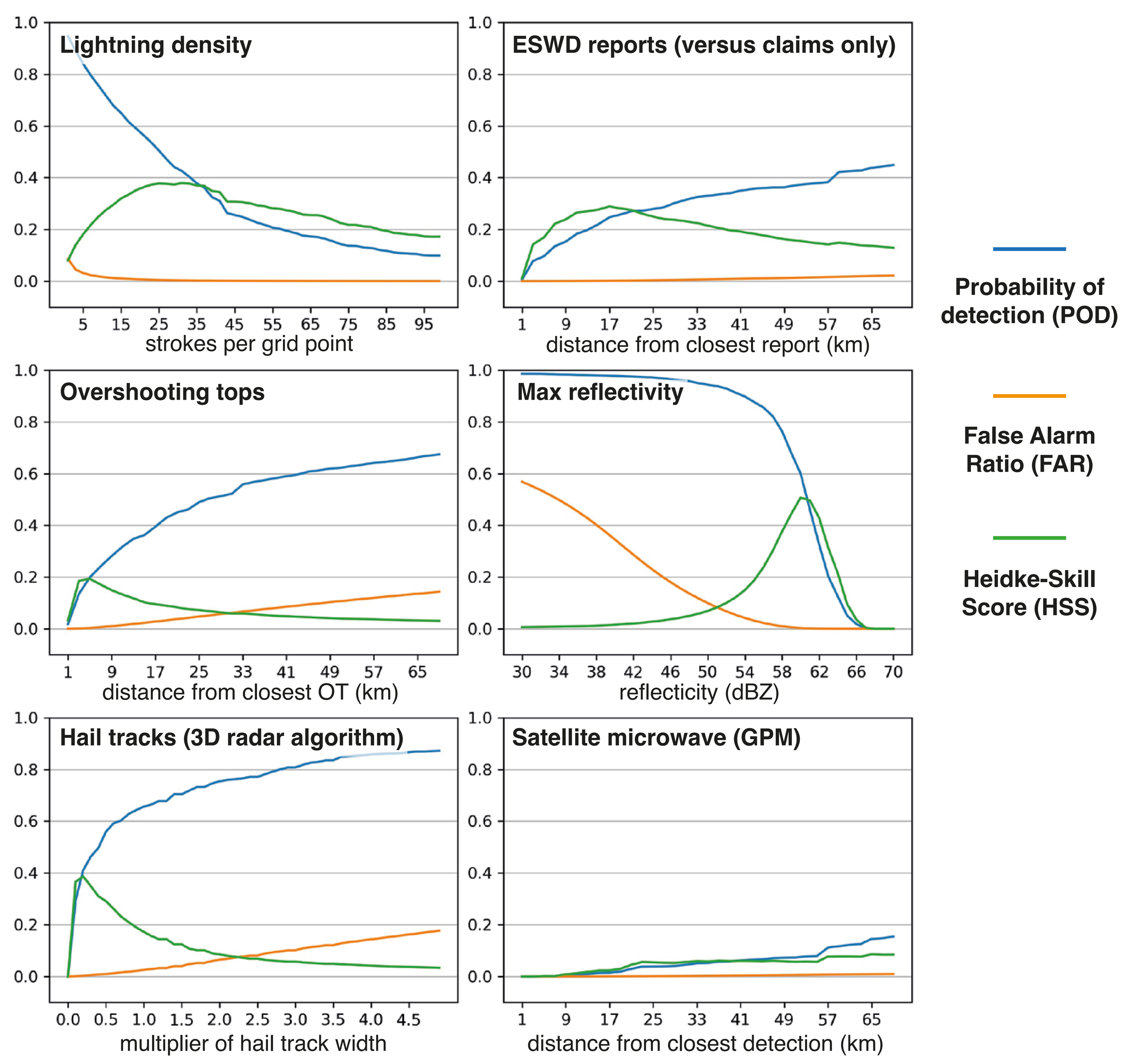
The threshold is varied (e.g., 30 strokes per grid point yielding less false alarms)

Example: lightning density on 07/10



For all proxies and 93 days

Skill metrics for varying thresholds



Take-home messages

- **While radar-based proxies have the highest skill, no single proxy is fully reliable**
- **Satellite-based detections: OTs shows some skill, justifying their use in climatologies [7], while the skill of GPM detections is low over Germany**
- **ESWD reports underrepresent crop damage claims (0.5 cm hail can already damage plants), but ...**
- **Insurance data is also not perfect (claims can be fraud, caused by Graupel, or non-uniformly distributed)**

References:

[1] Schulz, W., Diendorfer, G., Pedeboy, S., and Poelman, D. R.: The European lightning location system EUCLID – Part 1: Performance analysis and validation, Nat. Hazards Earth Syst. Sci., 16, 595–605

[2] Nikolai Dotzek, Pieter Groenemeijer, Bernold Feuerstein, Alois M. Holzer, Overview of ESSL's severe convective storms research using the European Severe Weather Database ESWD, Atmospheric Research, Volume 93, Issues 1–3, 2009

[3]Bedka KM (2011) Overshooting cloud top detections using MSG SEVIRI infrared brightness temperatures and their relationship to severe weather over Europe. Atmos Res 99.

[4] Showed best skill in: Ortega, K. L. (2021). Evaluating Multi-Radar, Multi-Sensor Products for Surface Hailfall Diagnosis. E-Journal of Severe Storms Meteorology, 13(1).

[5] Schmidberger, M., 2018. Hagelgefährdung und Hagelrisiko in Deutschland basierend auf einer Kombination von Radardaten und Versicherungsdaten. Karlsruhe: KIT Scientific Publishing.

[6] Bang, S. D., and D. J. Cecil, 2019: Constructing a multifrequency passive microwave hail retrieval and climatology in the GPM domain. J. Appl. Meteor. Climatol., 58, 1889–1904

[7] E.g., for Europe: Punge K M, Bedka, H. J., Werner, M., & Kunz A. (2014). A new physically based stochastic event catalog for hail in Europe. Nat Hazards, 1625–1645.

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