Spatial and temporal analysis of hail streaks over Germany

Karlsruhe Institute of Technology

Sandra Freudenstein[(1)], Michael Kunz[(1)] and David Forger[(2)]

(1) Institute for Meteorology and Climate Research (IMK–TRO) at Karlsruhe Institute of Technology

(2) Blitz-Informationsdienst von Siemens (BLIDS), Karlsruhe, Germany

Main Results

- Hail streaks (> 100 km) show a pronounced north-to-south gradient and a less marked east-to-west gradient regarding the probability of occurrence.
- Longer hail streaks (> 160 km) exhibit a less pronounced diurnal variation compared to shorter tracks, meaning that large-scale lifting processes are relevant for those systems.
- No disparity in track lengths between northern and southern Germany (not illustrated).

Data sets and methods

How can hail streaks be identified?

ESWD data

- Hail reports provided by the European Severe Weather Database (ESWD)
- 'Large hail': QC0+, QC1, QC2

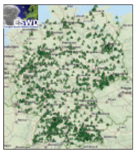

Fig. 1: 'Large hail' reported during 2001 – 2009 (www.essl.org/eswd)

Lightning data

- BLIDS – Siemens lightning information service
- Clusters identified by applying the 'BLIDS-Prophet'-algorithm

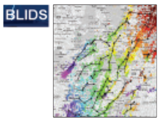

Fig. 2: Analysis by use of BLIDS-Prohpet, 17th July 2010 (Forger, 2010)

Insurance data

- Hail damage to agriculture
- > 60% of German farmers are members of insurance provider 'Vereinigte Hagel'

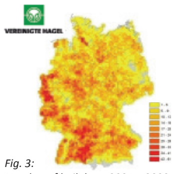

Fig. 3: Number of hail days, 2001 – 2009 (Puskeiler and Kunz, 2011)

Multicriteria approach:

- Lightning clusters are connected and identified as individual thunderstorm tracks over a 9-yr period (2001 – 2009)
- Minimum length: 100 km
- Matching with loss data (VH) and observations (ESWD) result in hail streaks
- Most applicable streaks were registered by searching for hail within a radius of 20 km

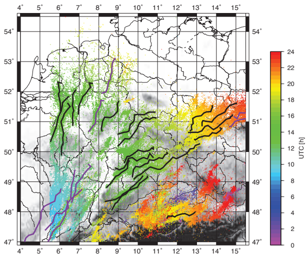

Fig. 4: Lightnings are coloured time-dependent, hail tracks are marked by black lines and tracks observed without hail reportings are marked by purple lines. (Freudenstein, 2013)

Assessment of hail streaks

Is there spatial or seasonal variability of hailstorms?

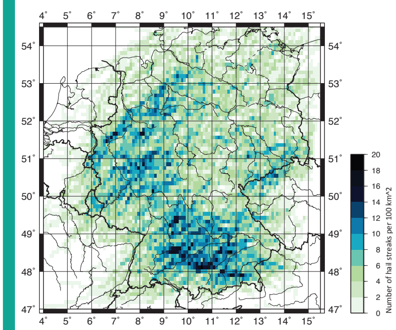

Fig. 5: Mean annual frequency distribution of hail streaks during May – August per 10 x 10 km² area

- Hot spots on the local scale were identified in
  South: Upper Bavaria, Swabia, esp. north of Swabian Jura
  West: Westerwald, Rhine Main Area, south of Eifel
- Spatial distribution depends on daytime (not illustrated)

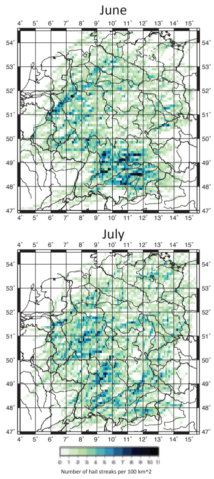

Fig. 6 and 7: Mean frequency distribution of hail streaks from 2001 – 2009 separated by month

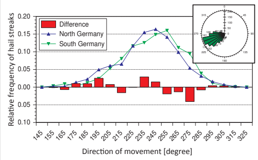

Fig. 8: Relative frequency of movement direction separated by regions. These data suggest that regional differences are due to orographic influence

- Maximum hail streak density is found near Stuttgart in June, which may be caused by horizontal flow convergence favoring the onset or intensification of deep convection

Time and place of initiation

How do time and place influence the initiation?

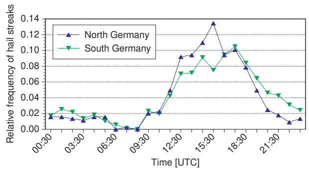

Fig. 9: Relative frequency of hail streaks as a function of initiation time

- There is a temporal disparity around an hour regarding the initiation time of hail streaks when distinguishing between northern and southern Germany

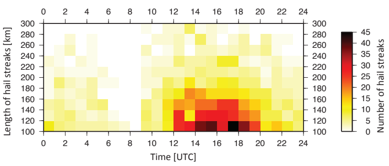

Fig. 10: Length of hail streaks as a function of initiation time from May – August summed over a 9-yr period

- Shorter hail streaks (< 160 km) exhibit an evident diurnal variation

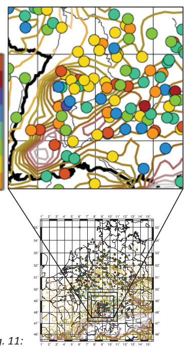

Fig. 11: June: Place of initiation depends on initiation time with picture detail of Baden-Wuerttemberg

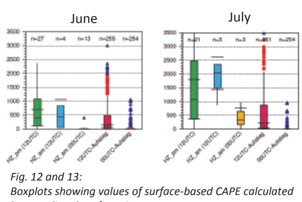

Fig. 12 and 13: Boxplots showing values of surface-based CAPE calculated by sounding data from Stuttgart

- Many hail streaks initiated in the vicinity of Stuttgart in June seem to be triggered by large-scale lifting processes
- In July deep convection is mainly triggered by processes in the boundary layer due to high values of surface-based CAPE

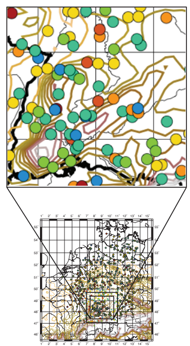

Fig. 14: July: Place of initiation depends on initiation time with picture detail of Baden-Wuerttemberg

Freudenstein, S., 2013: Räumliche und zeitliche Analyse von Hagelzugbahnen über Deutschland unter Verwendung verschiedener Beobachtungsdaten. Diploma thesis at Institute for Meteorology and Climate Research, Karlsruhe Institute of Technology.
Puskeiler, M. and Kunz, M., 2011: Assessment of the hail hazard from a combination of radar and insurance data. EGU, Vienna.
Forger, D., 2010: Verbesserung des BLIDS Alarm. Bachelor thesis at Hochschule Mannheim, University of Applied Sciences.
Kunz, M., J. Sander and C.Kottmeier 2009:Recent trends of thunderstorm and hailstorm frequency and their relation to atmospheric characteristics in southwest Germany. Int. J. Climatol., 29 (15), 2283–2297.