The life-cycle of hail storms: lightning, radar reflectivity and rotation characteristics

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Objectives

What is the typical life cycle of hail storms?

Which signatures are visible in …

… radar data?

… lightning data?
Hail storm near Main river: 20 June 2013

2D-radar reflectivity and lateral view
Hail storm near Main river: 20 June 2013

chronological sequence of lightning strokes

• lightning strokes
Δ ESWD hail

10km
Hail storm near Main river: 20 June 2013

- KONRAD
- O Overshooting top

Lightning jumps indicate severe weather.

number of strokes (<15km)

0  50  100  150  200  250  300
Hail storm near Main river: 20 June 2013

- Lightning jumps indicate severe weather.
- Overshooting tops indicate severe weather.

number of strokes (<15km)

0  50  100  150  200  250  300
Hail storm near Stuttgart: 28 July 2013

28.7.2013
00-24 UTC

lightning jumps

ESWD hail reports

strokes per km²

0 4 8 12 16 20
Hail storm in Allgäu: 03 May 2013

Mai 03 2013
Fr 14:25 UTC

number of strokes (<15km)

0 25 50 75 100 125 150

● KONRAD

Radar Fr 03.05.13 14:25 UTC 1.5° Sweep [m/s] - 1°x1km, 5 minütig <BUFR>
Hail storm in Allgäu: 03 May 2013

Mai 03 2013
Fr 14:30 UTC

number of strokes (<15km)

0 25 50 75 100 125 150

KONRAD

Radar
Fr 03.05.13 14:30 UTC 1.5° Sweep [m/s] - 1°x1km, 5 minütig <BUFR>
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Mesocyclones (supercells) can be detected in radar data.
Data basis

- April to September 2008 to 2015
- ESWD hail events with QC1 or QC2

- **821 hail events:**
  - in 94% of the cases KONRAD cell (15 km² ≥46 dBZ in 2D reflectivity)

- filtering:
  - hail reports > 10min apart
  - For life cycle study: track >15min

- 600 events on 172 days

hailstorm tracks with 2D radar reflectivity, mesocyclone and lightning information
Tracks synchronised relative to time of hail.
Life-cycle analysis

High reflectivity:
- $12 \text{ km}^2 \geq 55\text{dBZ}$ or
- $1 \text{ km}^2 \geq 60\text{dBZ}$

Mesocyclone: detected in radar radial wind data
Hailflag 2 – lead time

![Histogram showing lead time distribution](image)

- Frequency on the y-axis.
- Leadtime (min) on the x-axis.
Mesocyclone – lead time
Lightning Jump - definition

Lightning Jump Intensity:
Function of lightning rate and its tendency

Lightning rate change relative to standard deviation

Lightning rate change relative to standard deviation

strokes within 15km and 5min

LJ intensity
Lightning Jump - leadtime

![Bar chart showing frequency of leadtime in minutes]

- The x-axis represents leadtime in minutes, ranging from -180 to 60.
- The y-axis represents frequency.
- The chart uses different colors for different leadtime intervals: 0.1, 0.3, 0.5, 0.7.

2nd European Hail Workshop 2017, Bern - Kathrin Wapler (DWD)
Satellite signatures like *overshooting tops* indicate severe weather.
Hail cells have high reflectivities.
Nearly 3/4 of all hail events associated with mesocyclone.
Hail cells have high lightning densities.
Half of the analysed hailstorms have pulsating lightning activity (not shown).
*Lightning jumps* precede many hail events.

**Summary**

**Interested in more information?**