

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

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Objectives

What is the typical life cycle of hails storms?

Which signatures are visible in ...

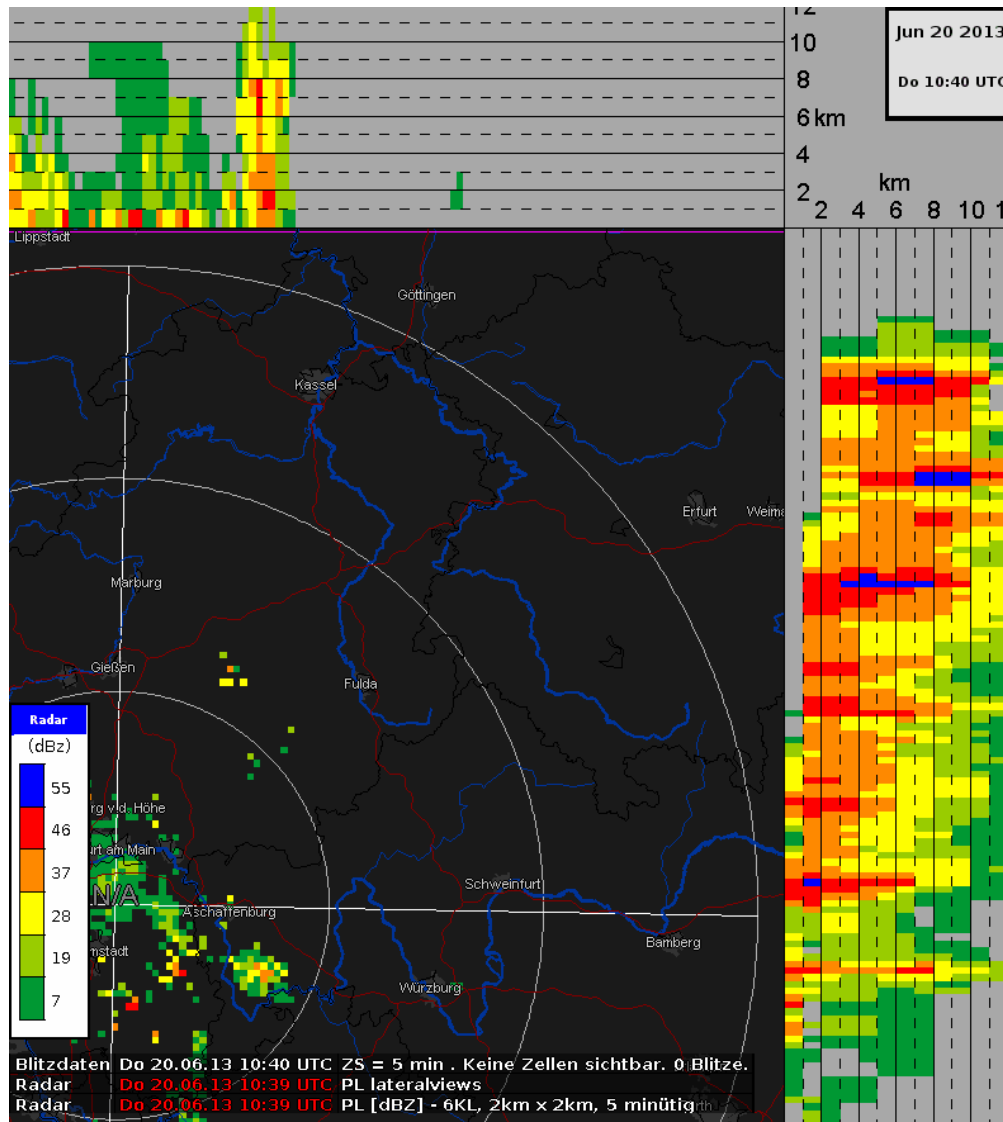
... radar data?

... lightning data?



Hail storm near Main river: 20 June 2013

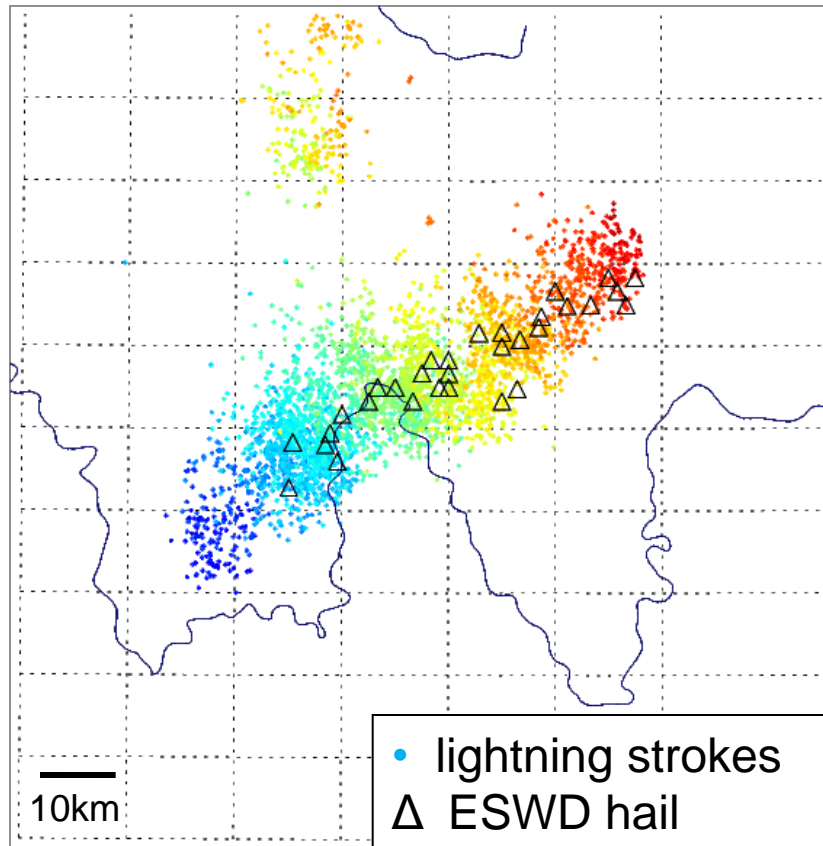
Deutscher Wetterdienst
Wetter und Klima aus einer Hand



2D-radar reflectivity and lateral view

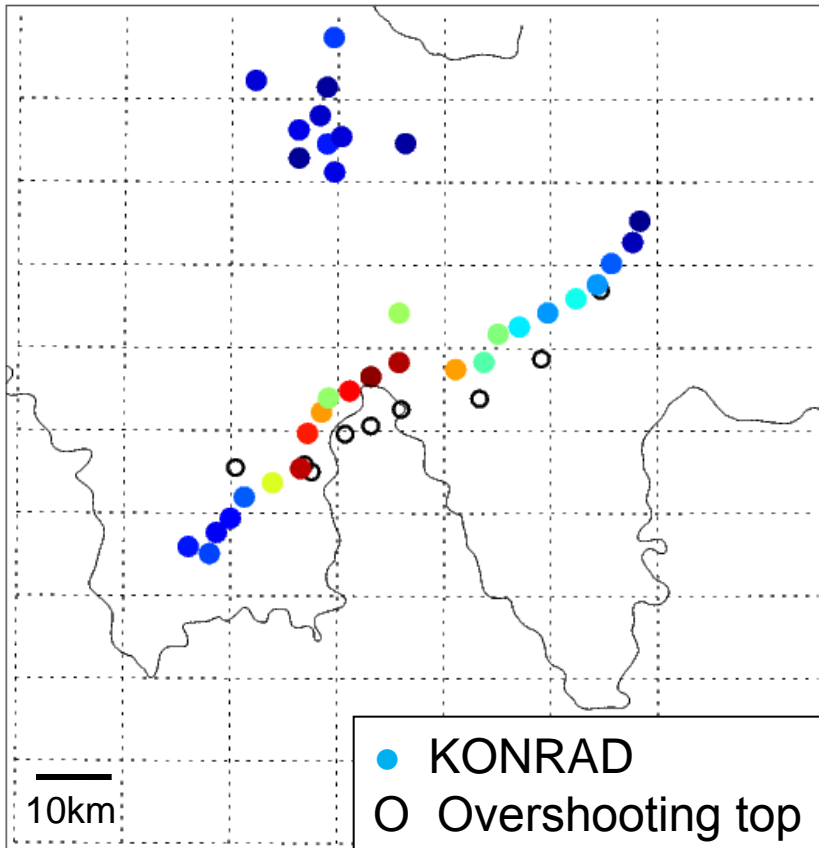


Hail storm near Main river: 20 June 2013

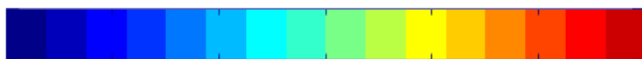


chronological sequence of lightning strokes

Hail storm near Main river: 20 June 2013



number of strokes (<15km)

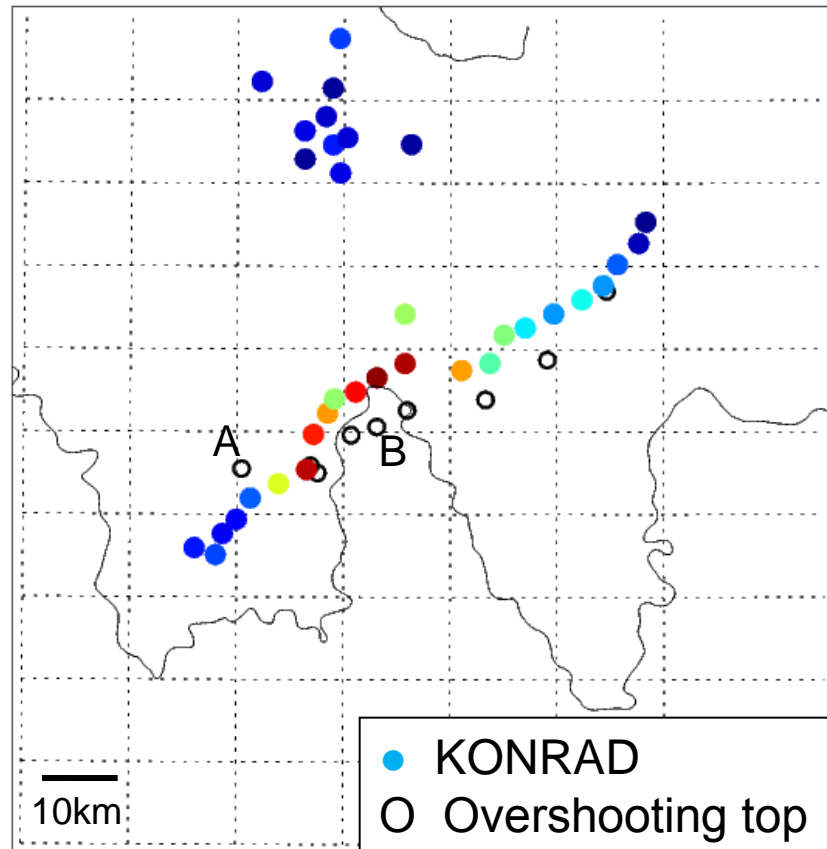


0 50 100 150 200 250 300

- *Lightning jumps* indicate severe weather.

overshooting top data kindly provided by
Martin Setvak and Michaela Radova, CHMI

Hail storm near Main river: 20 June 2013

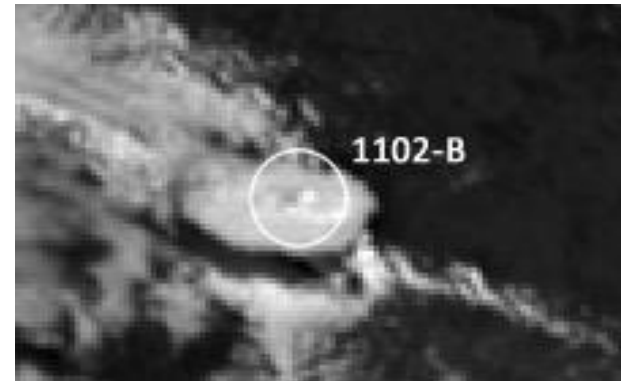


number of strokes (<15km)

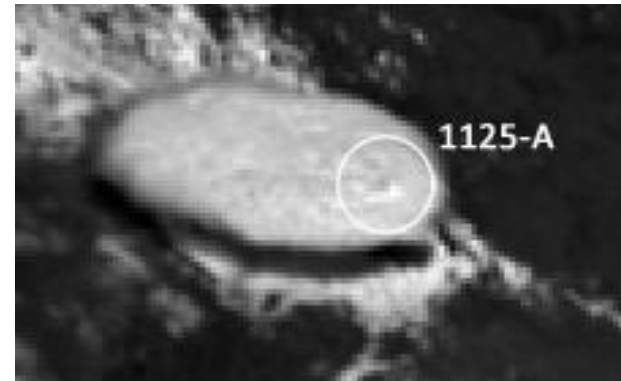


0 50 100 150 200 250 300

A



B



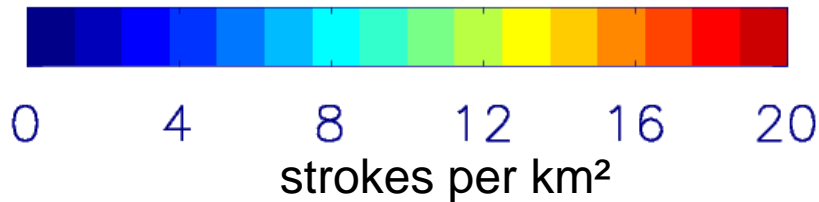
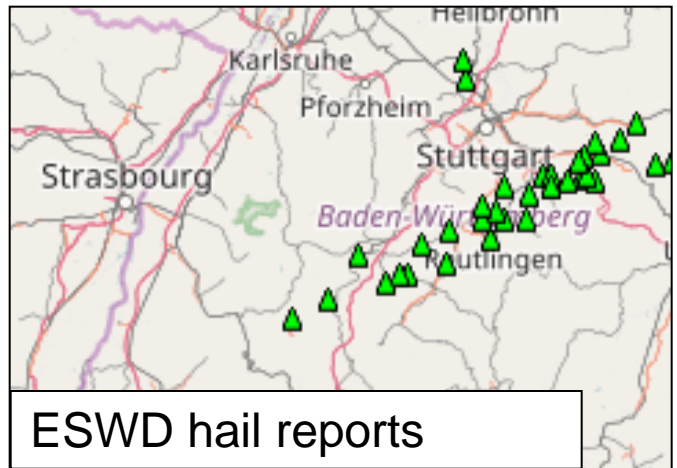
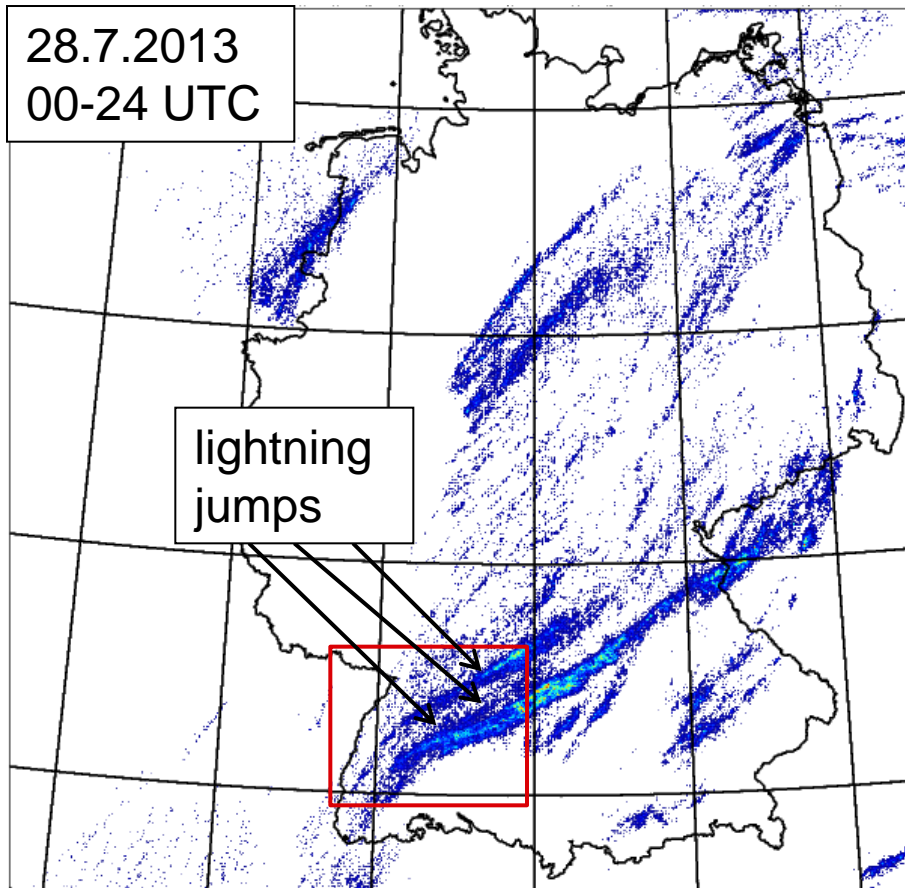
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overshooting top data kindly provided by
Martin Setvak and Michaela Radová, CHMI

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

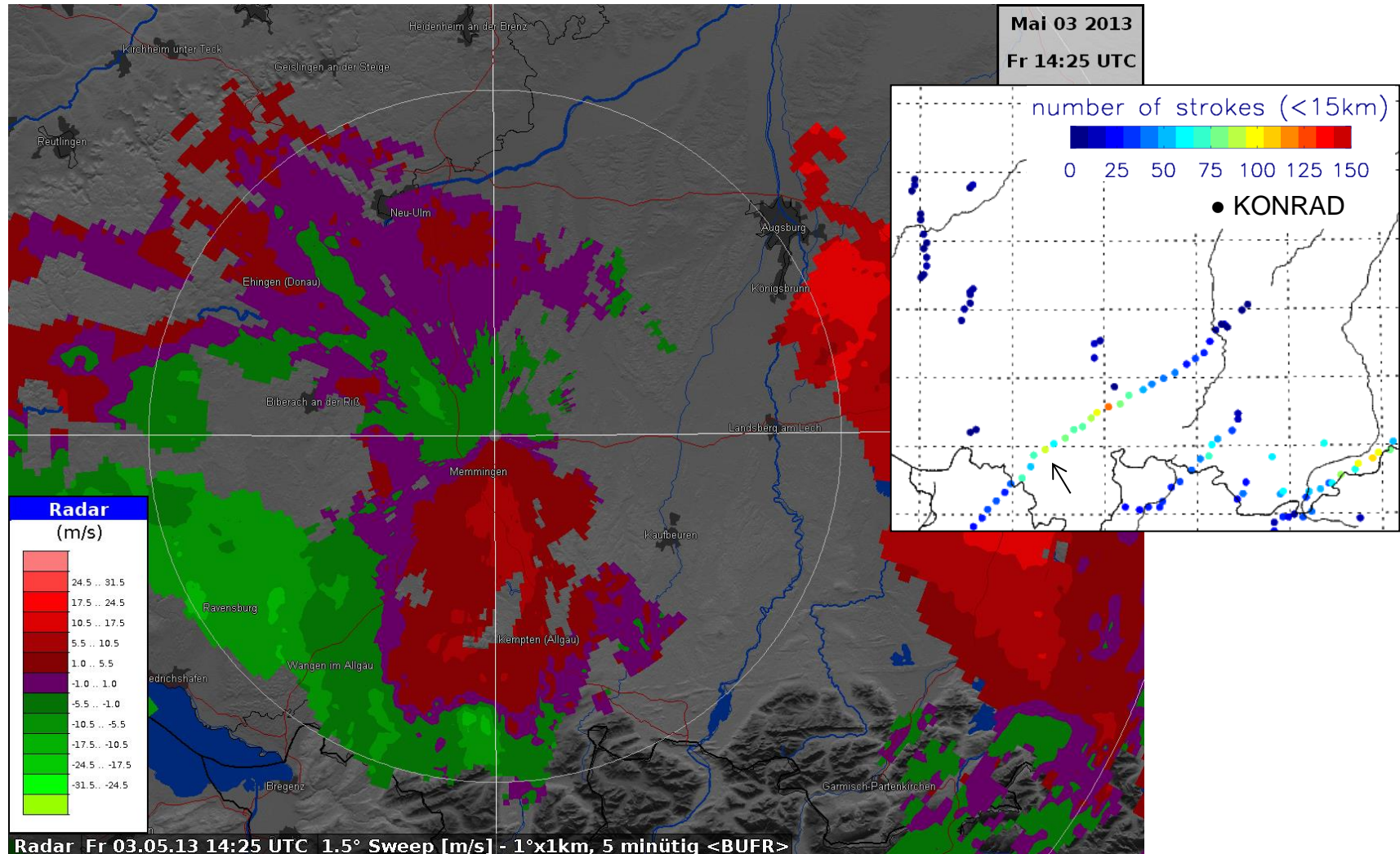
Hail storm near Stuttgart: 28 July 2013

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



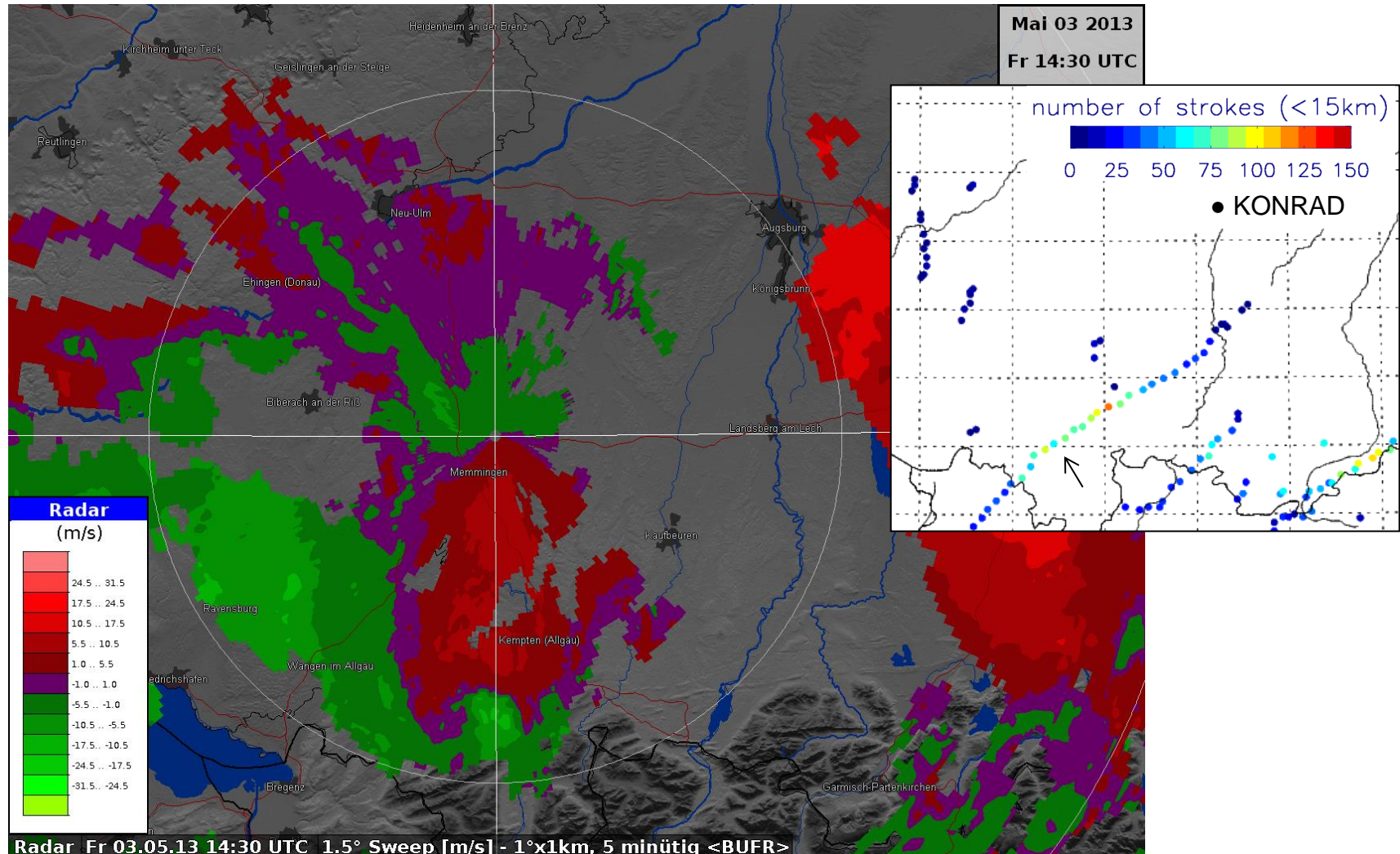
Hail storm in Allgäu: 03 May 2013

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



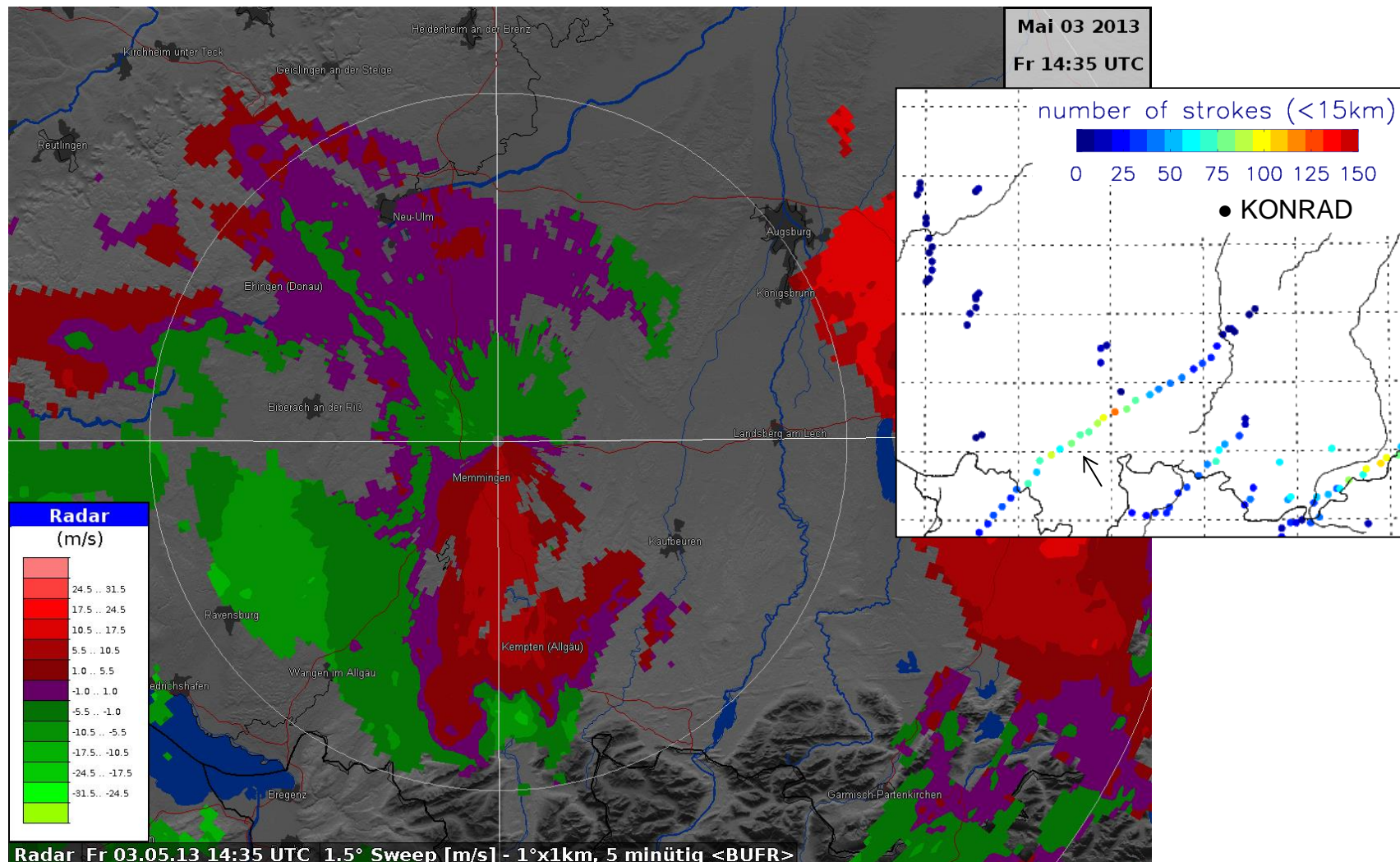
Hail storm in Allgäu: 03 May 2013

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Wetter und Klima aus einer Hand



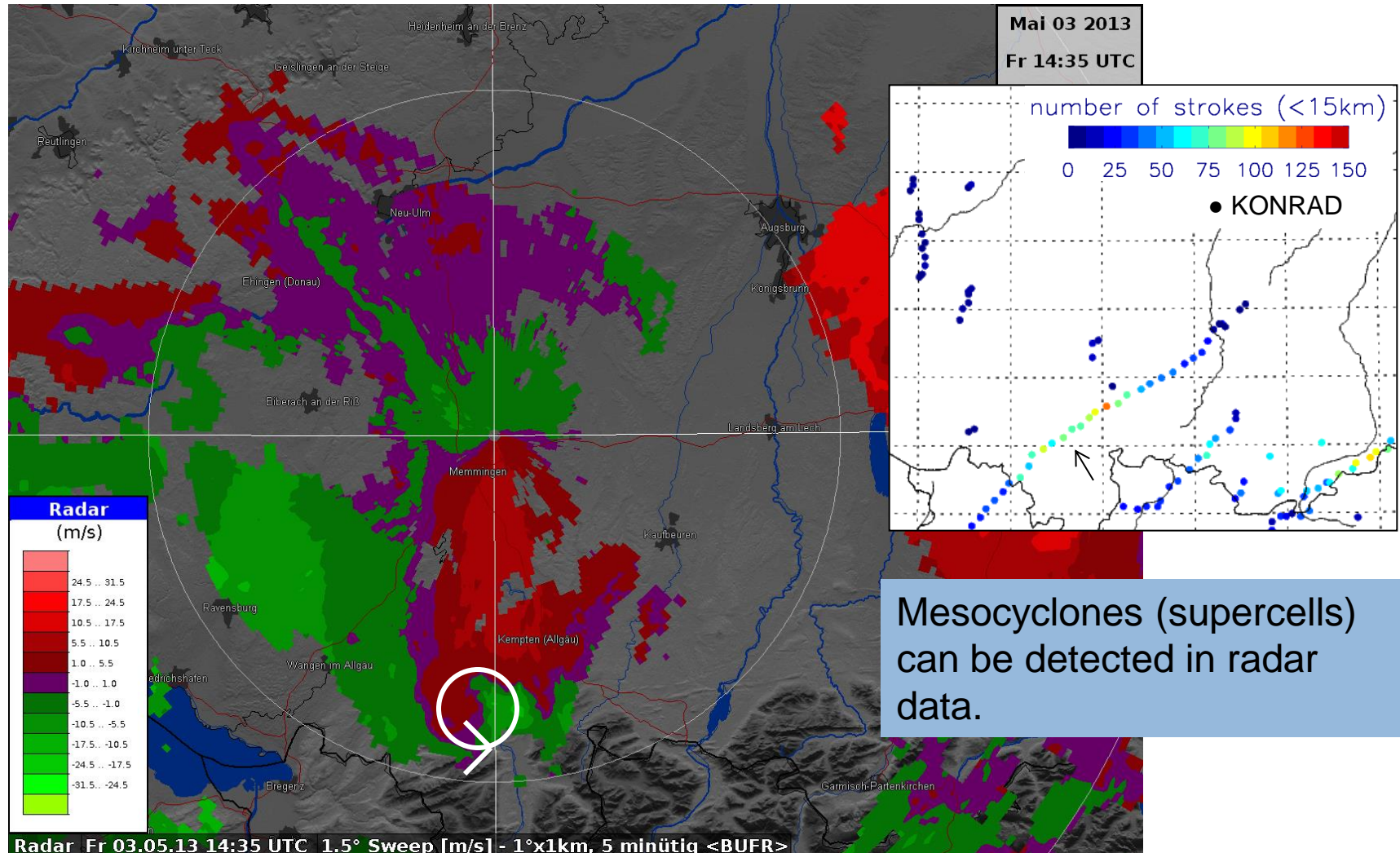
Hail storm in Allgäu: 03 May 2013

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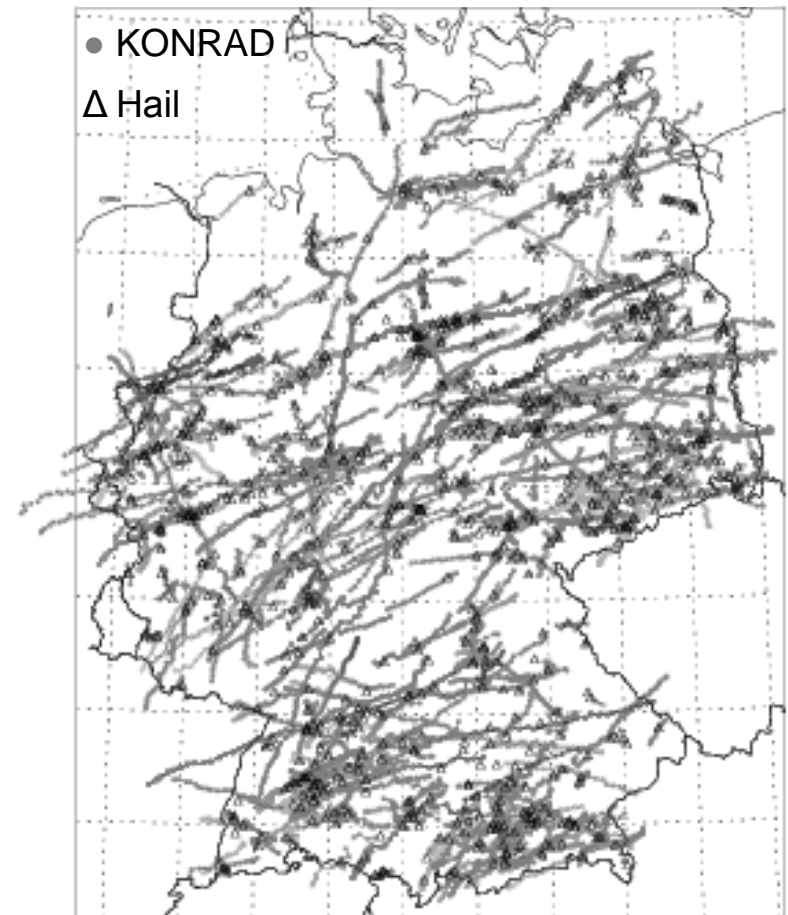
Hail storm in Allgäu: 03 May 2013

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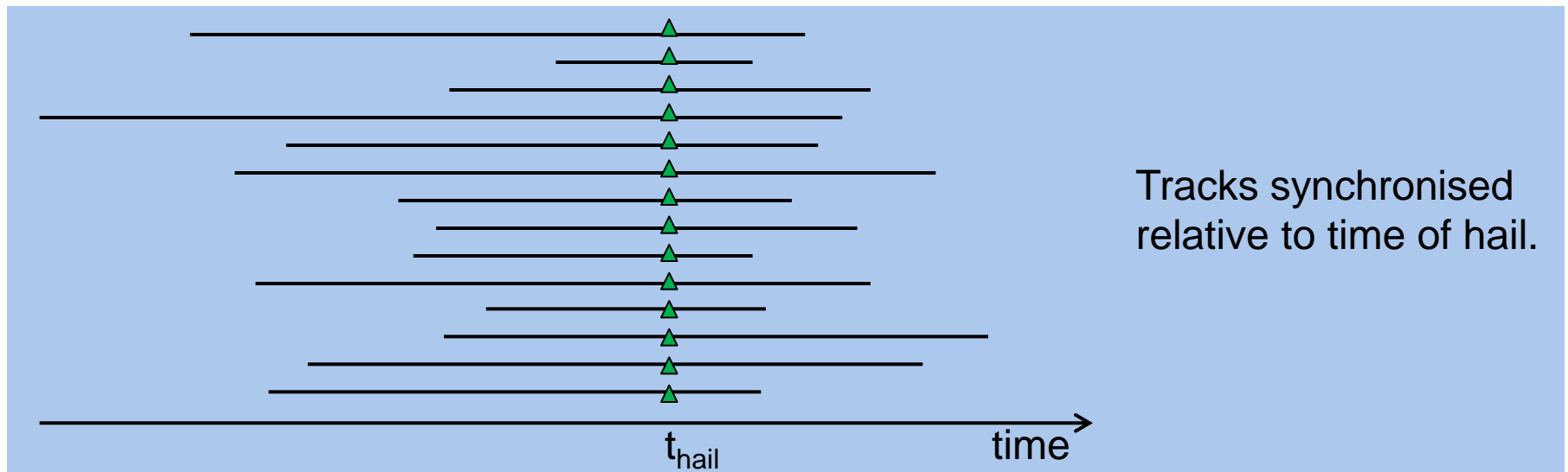
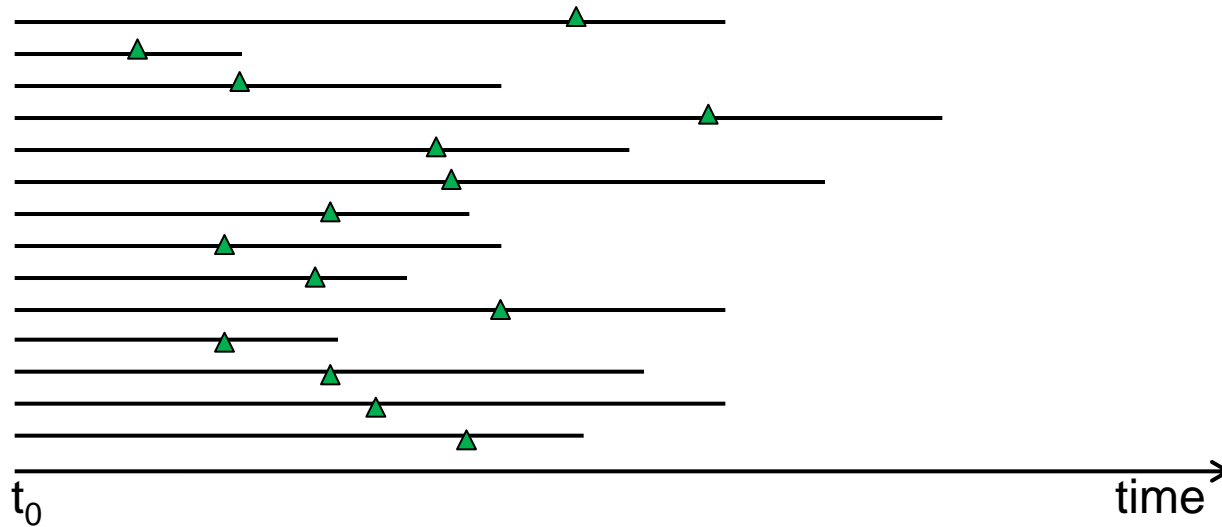
Data basis

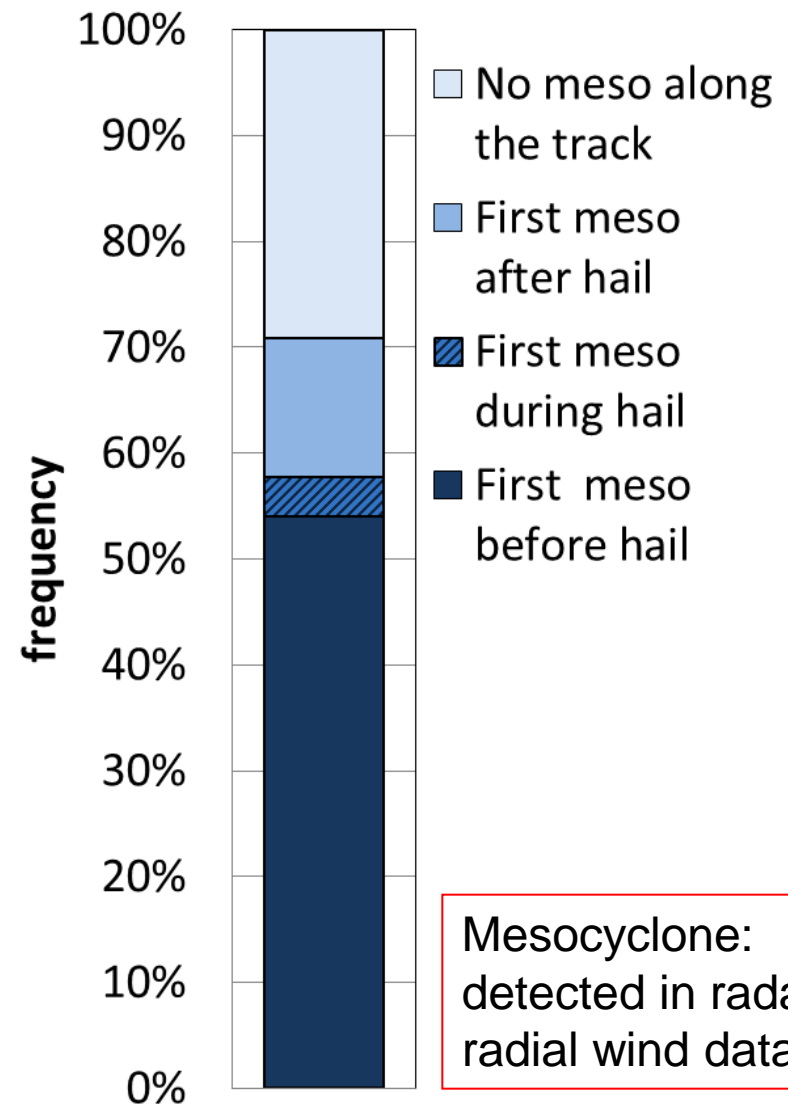
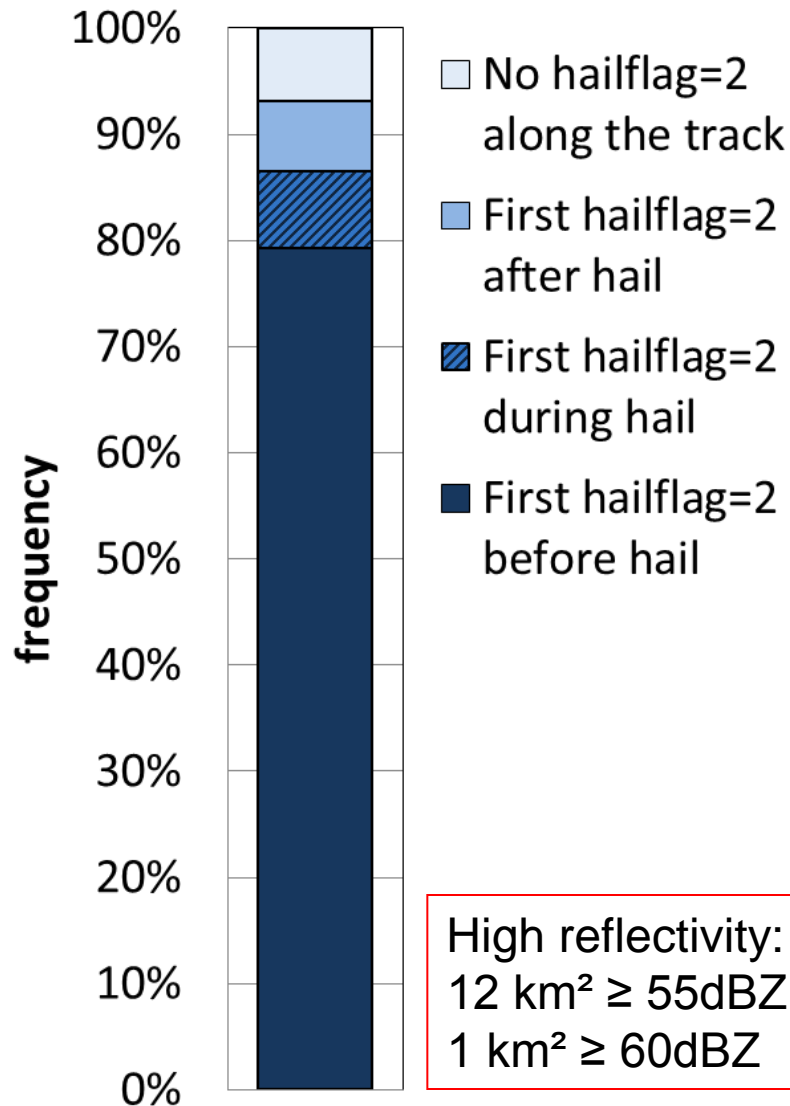
- April to September 2008 to 2015
- ESWD hail events with QC1 or QC2
- **821 hail events:**
in 94% of the cases KONRAD cell
($15 \text{ km}^2 \geq 46 \text{ dBZ}$ in 2D reflectivity)
- filtering:
 - hail reports > 10min apart
 - For life cycle study: track > 15min
- **600 events on 172 days**



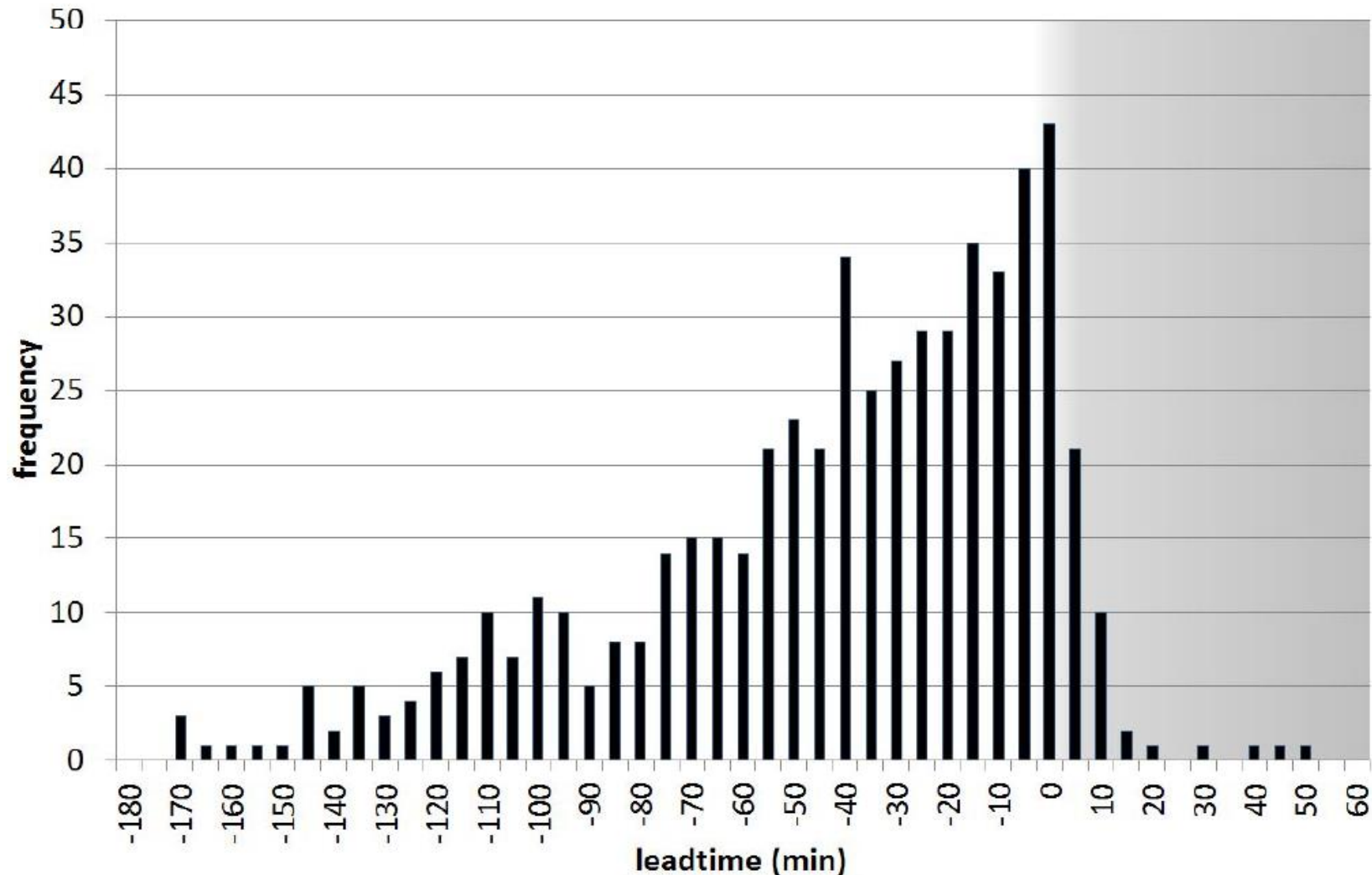
hailstorm tracks with 2D radar reflectivity, mesocyclone and lightning information

Life-cycle analysis

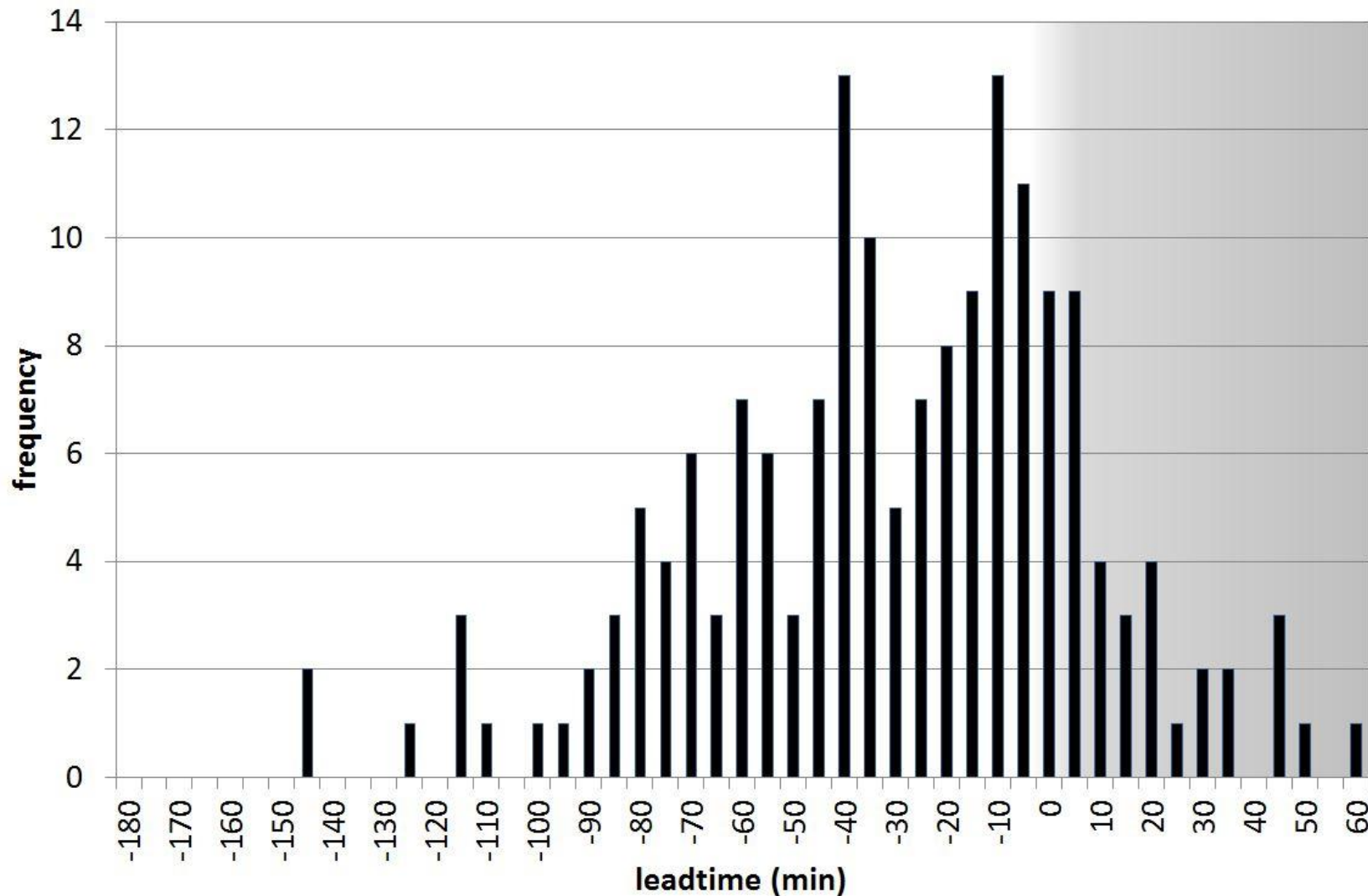




Hailflag 2 – lead time

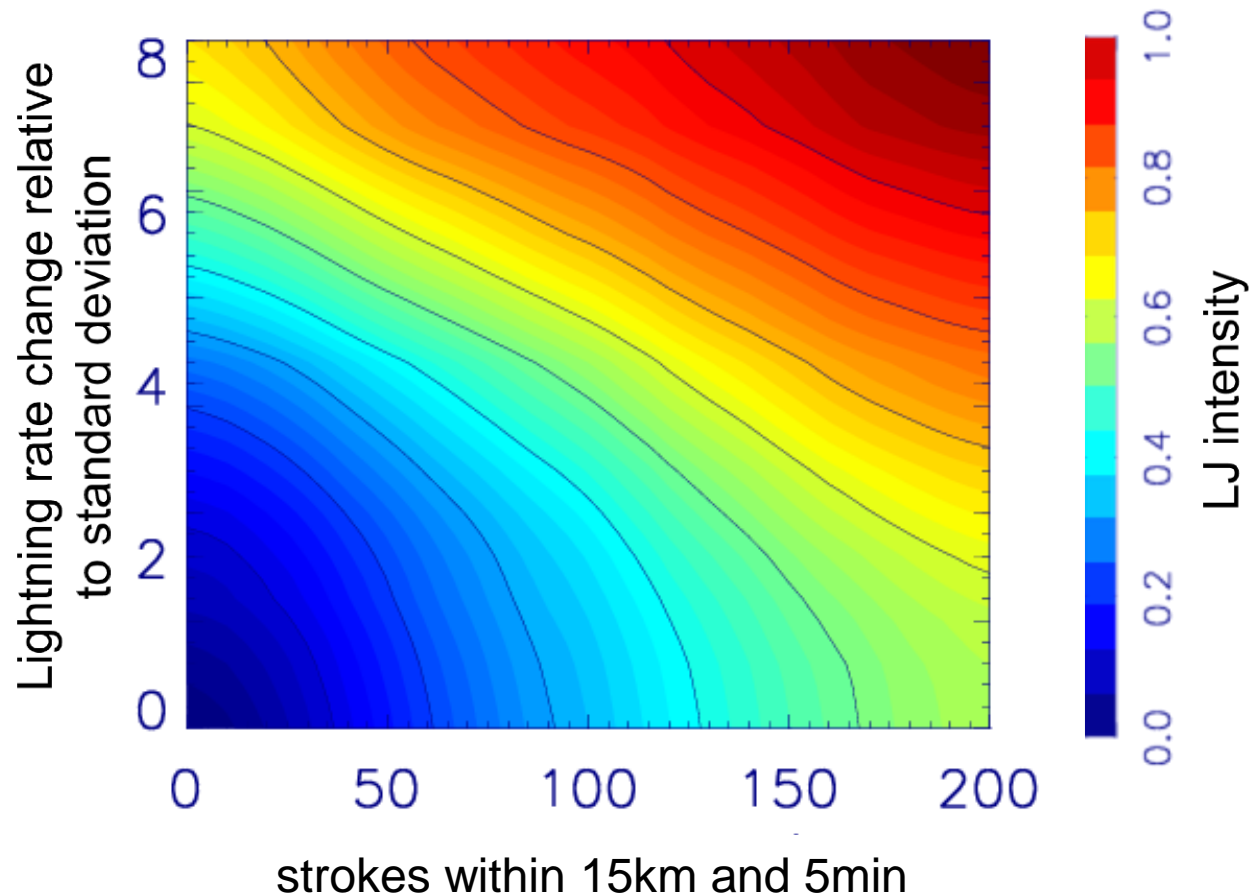


Mesocyclone – lead time

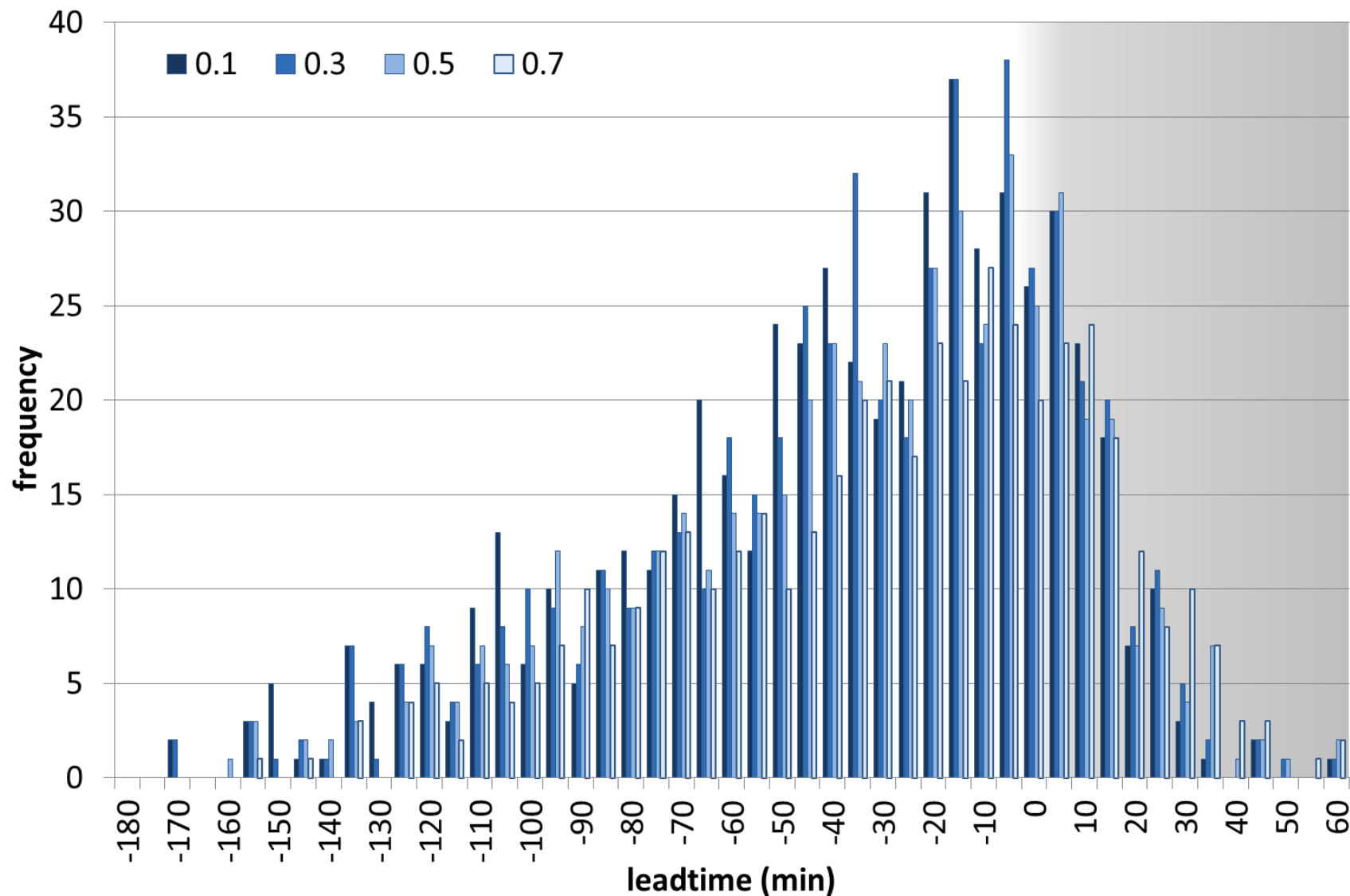


Lightning Jump Intensity:

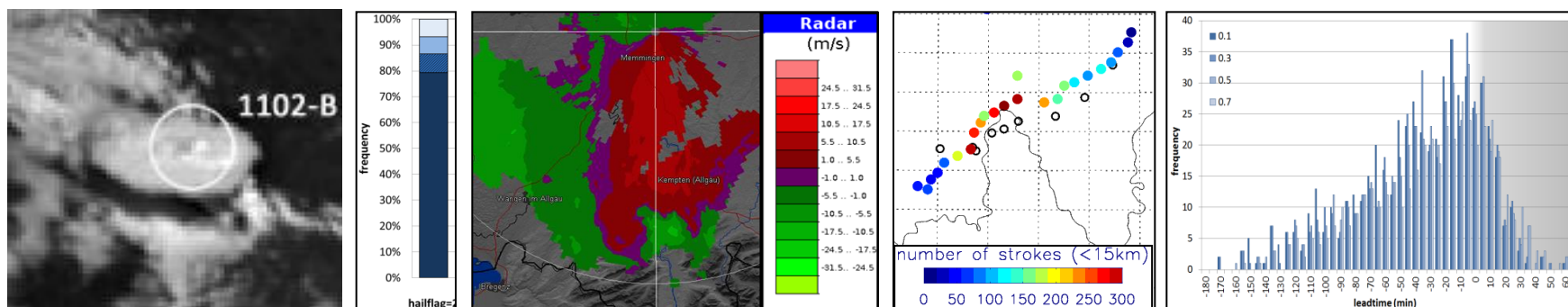
Function of lightning rate and its tendency



Lightning Jump - leadtime



- 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.



Interested in more information?

Wapler, K., et al. (2016): Mesocyclones in Central Europe as seen by Radar. *Atmos. Research*, 168, 112-120.

Wapler, K. (2017): The life-cycle of hailstorms: lightning, radar reflectivity and rotation characteristics. *Atmos. Res.*, 193, 60-72.