Generating a radar-based hail climatology for Belgium

Maryna Lukach, Laurent Delobbe

1ST EUROPEAN HAIL WORKSHOP

BERN, SWITZERLAND 2014

MACCBET

Modelling atmospheric composition and climate for the Belgian territory

RMI

Benefits of the radar-based statistics

Traditional sources of hail statistics: hail pads networks , newspapers, insurances, observers, and volunteers reports …

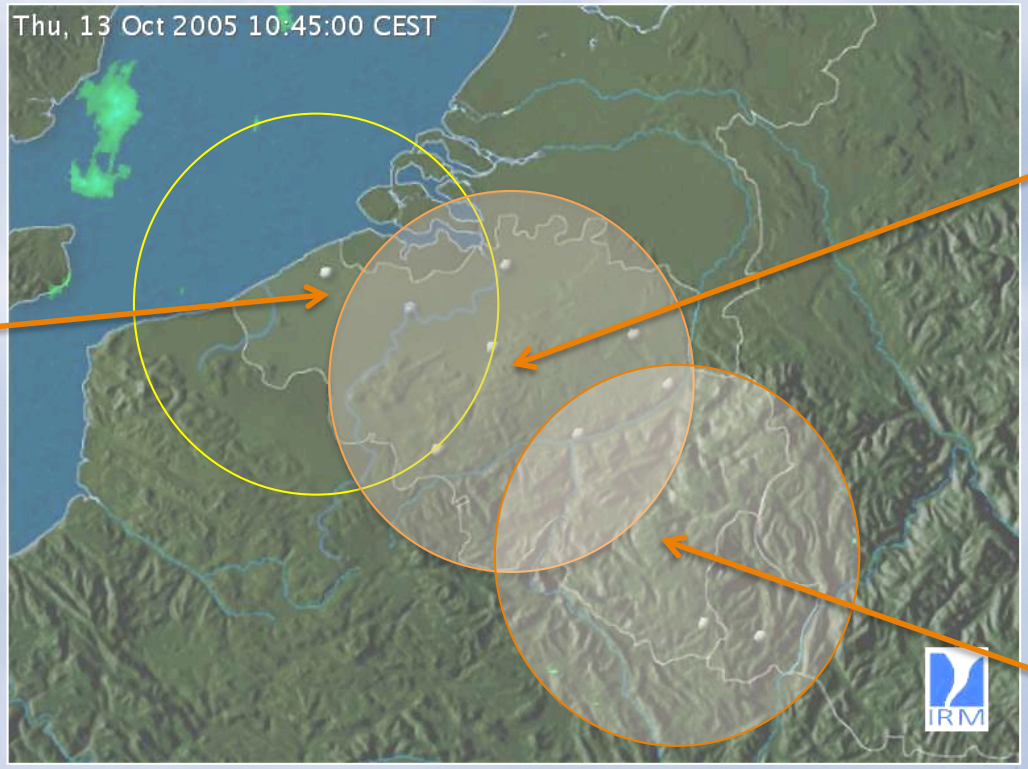
Compared to traditional sources radar-based data:

- Have high temporal and spatial resolution
- Unbiased towards severe hail cases
- Not influenced by population density
- Measured day and night

Use of radar observations provide hail estimation at high temporal and spatial resolutions

Radars in Belgium

Jabbeke
RMI (2012)



radius = 100 km

Zaventem
Belgocontrol (2003)

Wideumont
RMI (2001)

High resolution volumetric measurements: 2003 - 2012

Temporal and Spatial Resolution

	Wideumont		
	Scan 1 (watchdog)	Scan 2 (volume)	Scan 3 (Doppler)
Quantity	Reflectivity Z	Reflectivity Z	Z, Velocity, Spectral Width
Range	240 km	240 km	120 km
Time interval	5 min	15 min	15 min
Data Resolution	1^0 250 m	1^0 500 m	1^0 250 m
Elevations	0.3° 0.9° 1.8° 3.3° 6.0°	0.5° 1.2° 1.9° 2.6° 3.3° 4.0° 4.9° 6.5° 9.4° 17.5°	0.5° 1.2° 2.1° 3.4° 5.6° 9.2° 15.2° 25.0°

Hail detection algorithms (HDA)

- Waldvogel's method

  Probability of hail (POH)

- Witt's method

  Probability of severe hail (POSH)

  Maximum expected hail size (MESH)

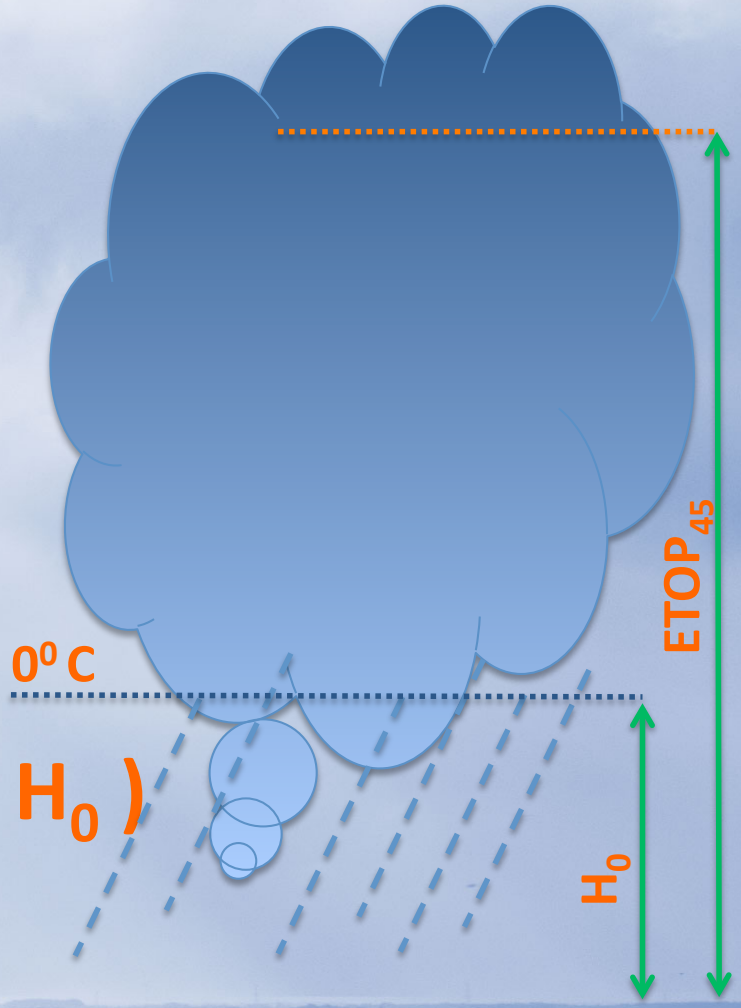
Hail detection algorithms

Waldvogel's method

$$ETOP_{45} \geq H_0 + 1.4$$

H_0 is a (0^0 C) – isotherm height

$ETOP_{45}$ is a height of 45dBZ echotop



POH – Probability of Hail

$$POH = 0.319 + 0.133\,(ETOP_{45} - H_0)$$

Holleman (2000)

Hail detection algorithms

Witt's or Severe Hail Index (SHI) – algorithm

Reflectivity → Flux of hail kinetic energy

$$E = 5 * 10^{-6} 10^{0.084 Z} W(Z)$$

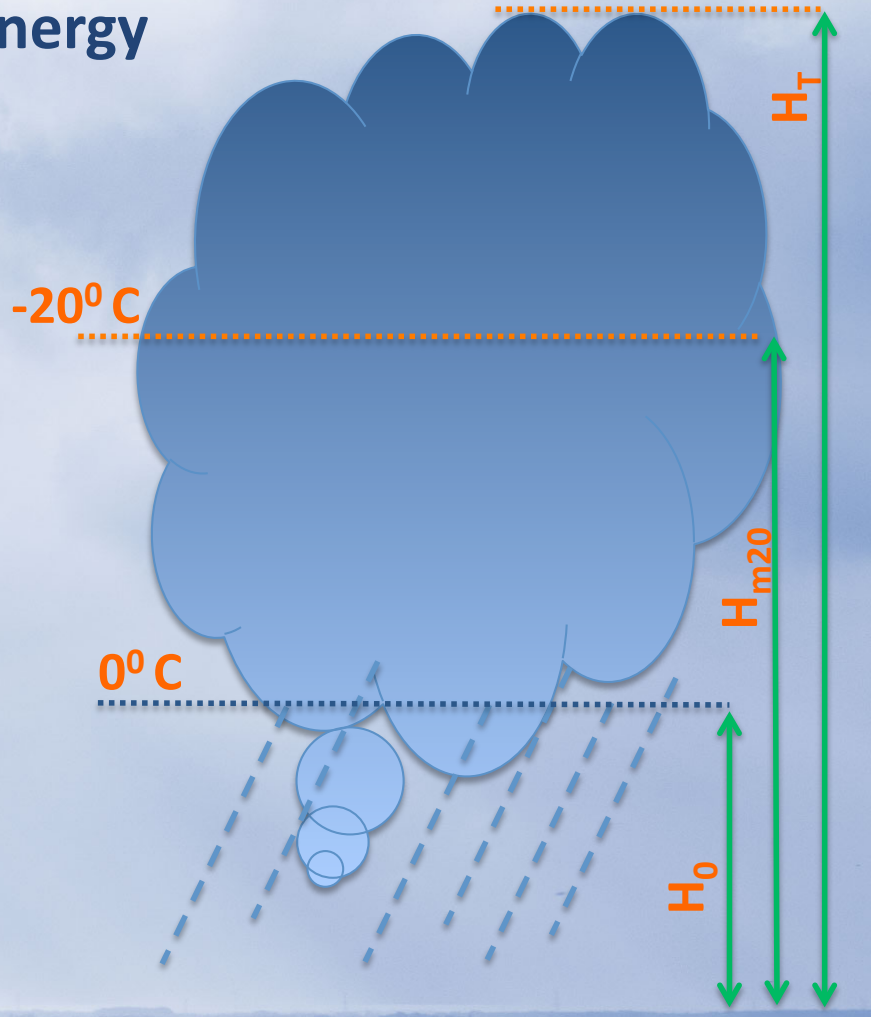
$$SHI = 0.1 \int_{H_0}^{H_T} W_T(H) E dH$$

MESH – Maximum Expected Size of Hail

$$MESH = 2.54 (SHI)^{0.5}$$

POSH – Probability of Severe Hail

$$POSH = 29 \ln\left(\frac{SHI}{WT}\right) + 50$$

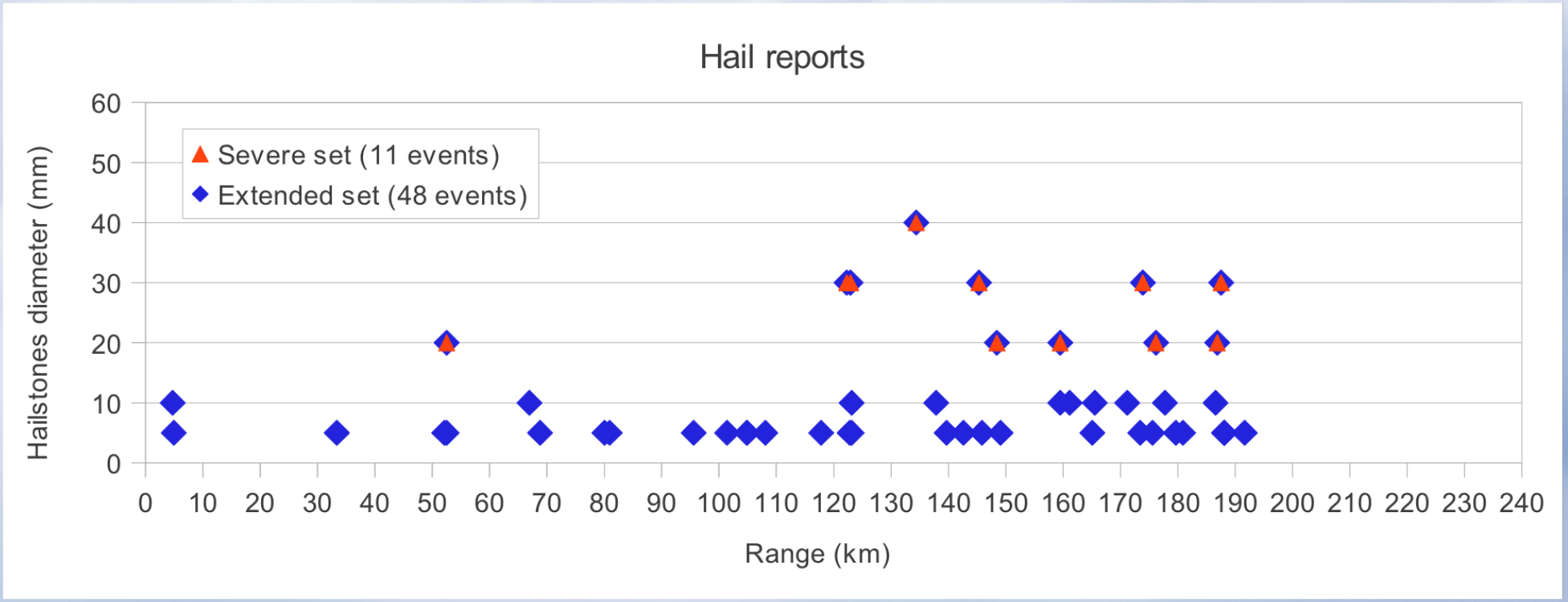


Verification possibilities

- **Verification campaign data**
  - Separate dates in 2002, 2003 and 2005
  - Time interval, location, hail size
- **Verification reports in climatology database**
  - More than 40 000 entries (1960-2012)
  - Date, grid cell, hail size
- **False alarm rate can not be estimated**

Verification campaign data

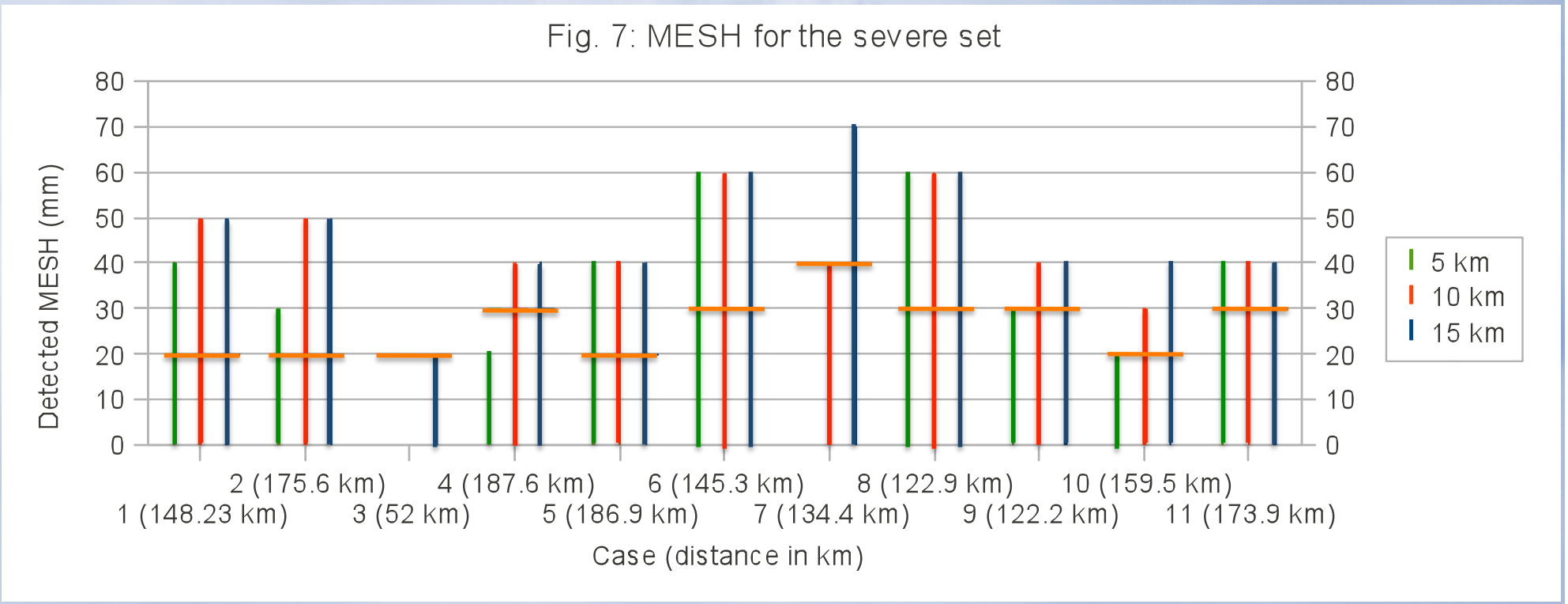
- **Hail reports 2002 – 2005**



- **Hail of all sizes (48 events)** ◆
- **Severe hail with ø > 20 mm (11 events)** ▲

Verification of Witt's MESH product

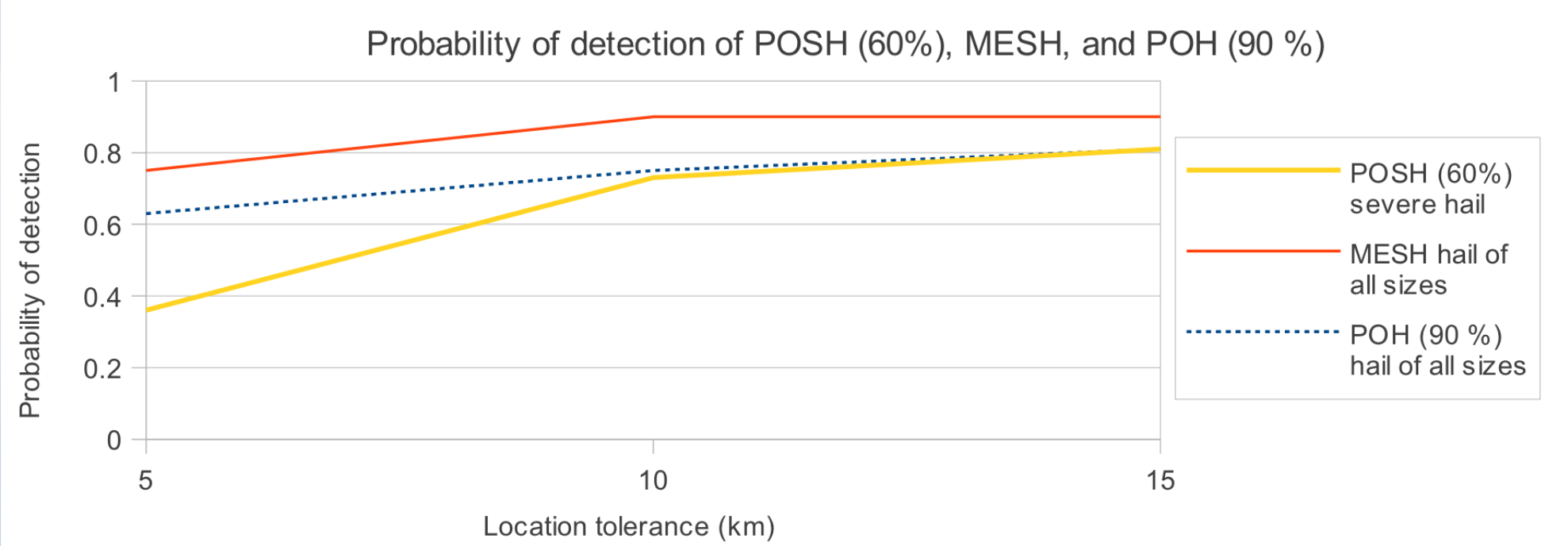
- **Probability of detection for MESH**



with 15 km tolerance: 20/23 (87 %), 43/48 (90 %), 10/11 (91 %)

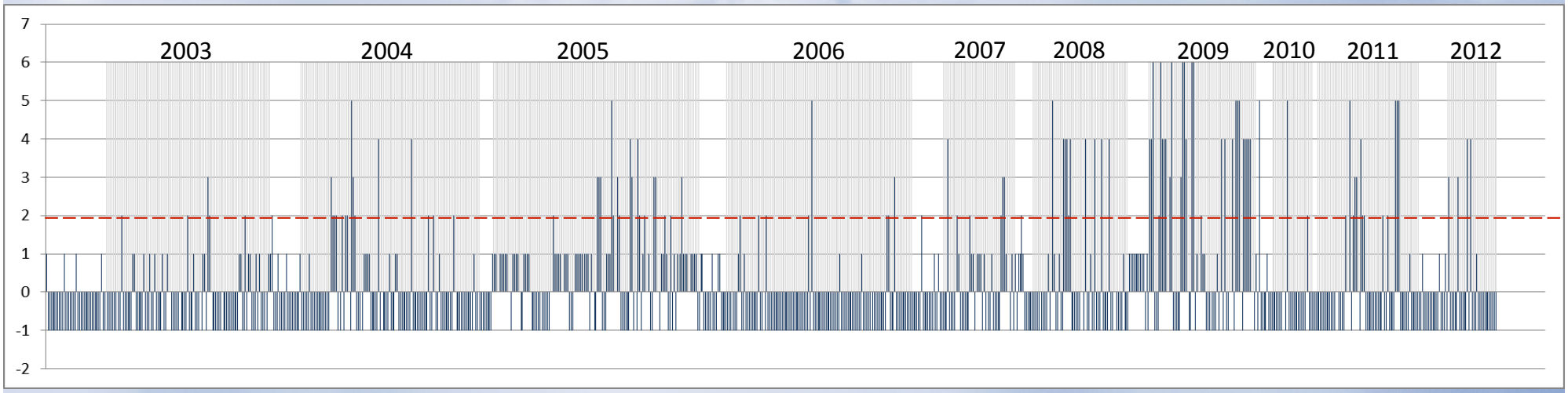
Verification campaign data

- POSH (60%), MESH, and POH (90%) with different distance tolerances



Verification on the climatological DB

Selection of reports:



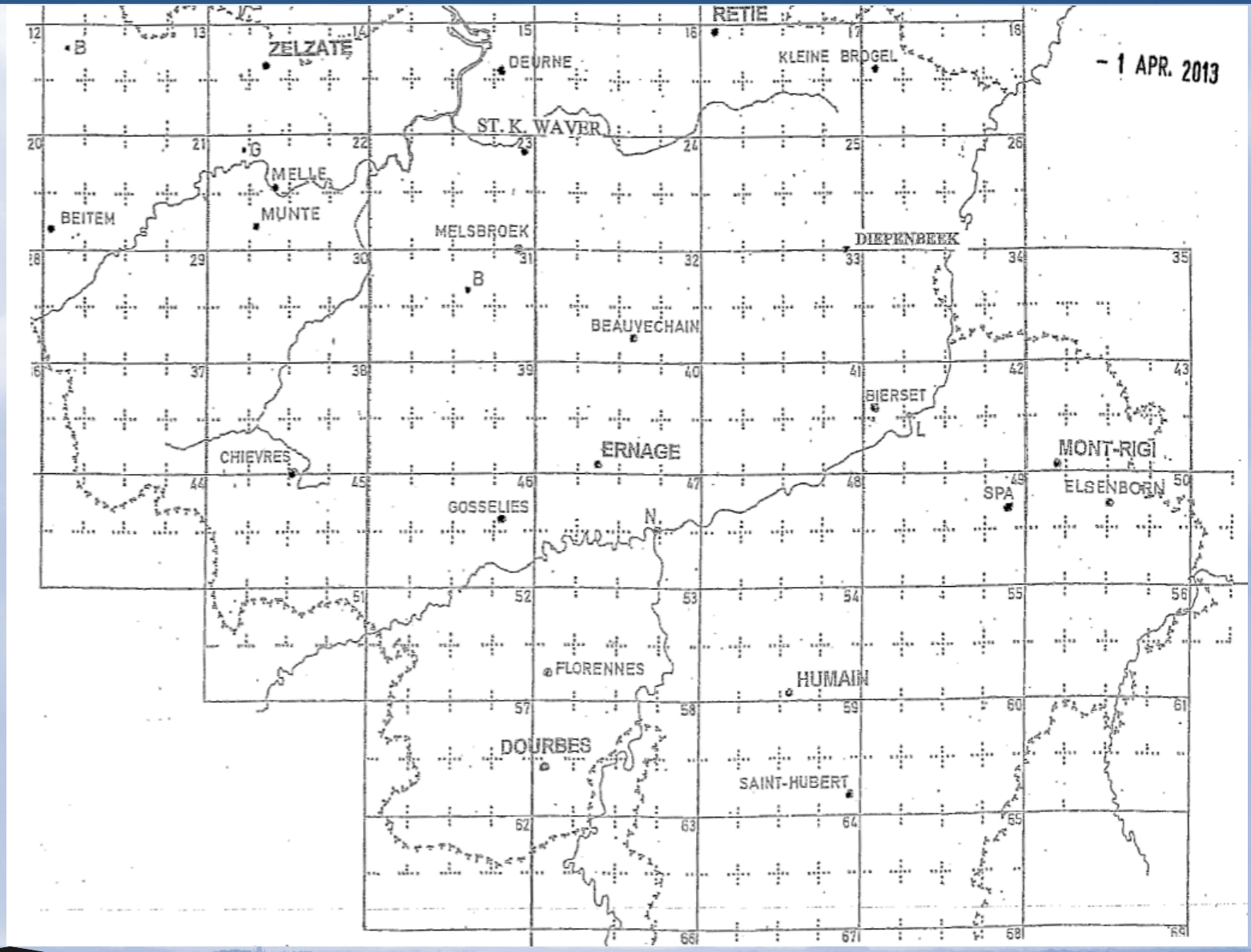
Climatological reports DB 1960 – 2012: 3670 reports

For 10 years between 2003 – 2012: 877 reports

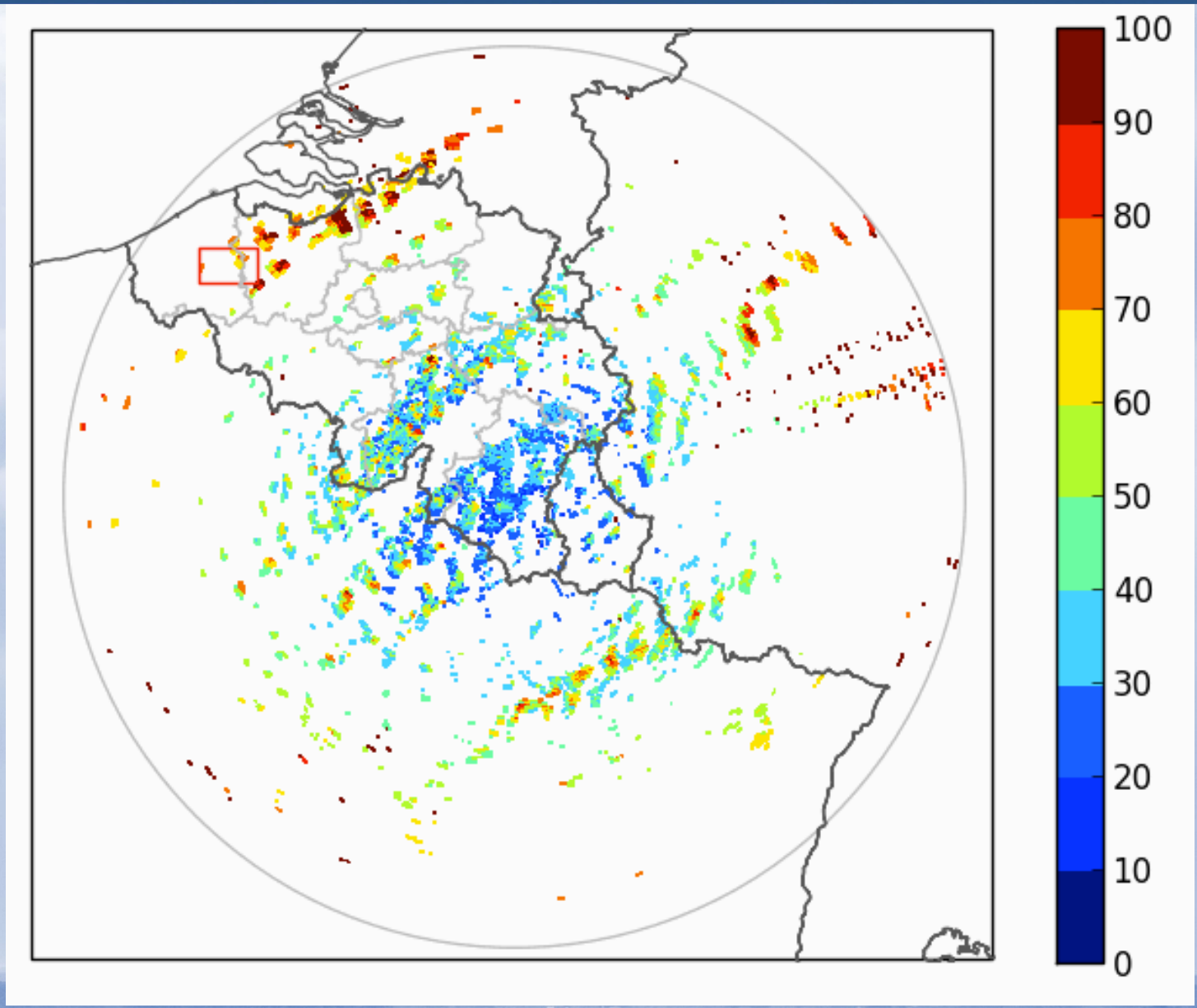
For 10 hail seasons April – October: 739 reports

For severe cases in 10 hail seasons: 261 reports

Localization in climatological DB

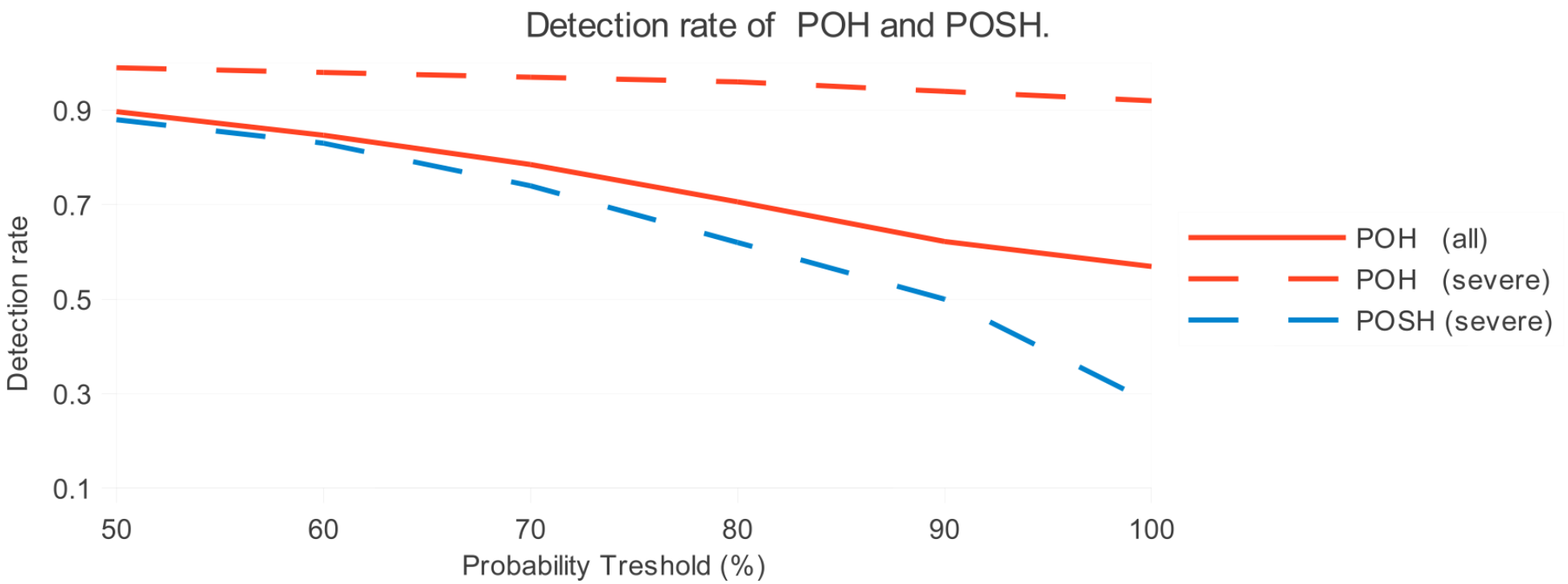


Role of Advection in Verification

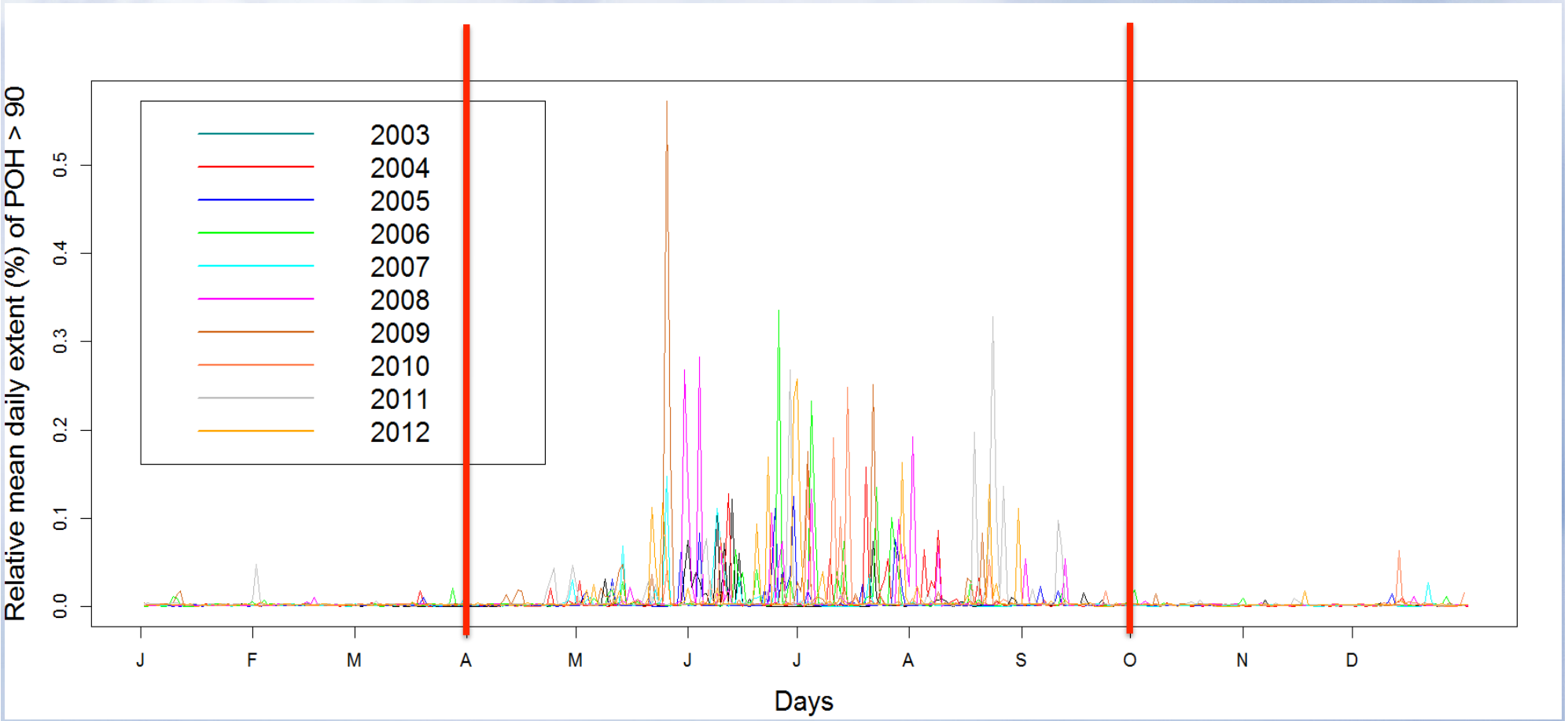


Verification of HDA's on the reports DB

Hail seasons 2003 - 2012:



Hail season in Belgium

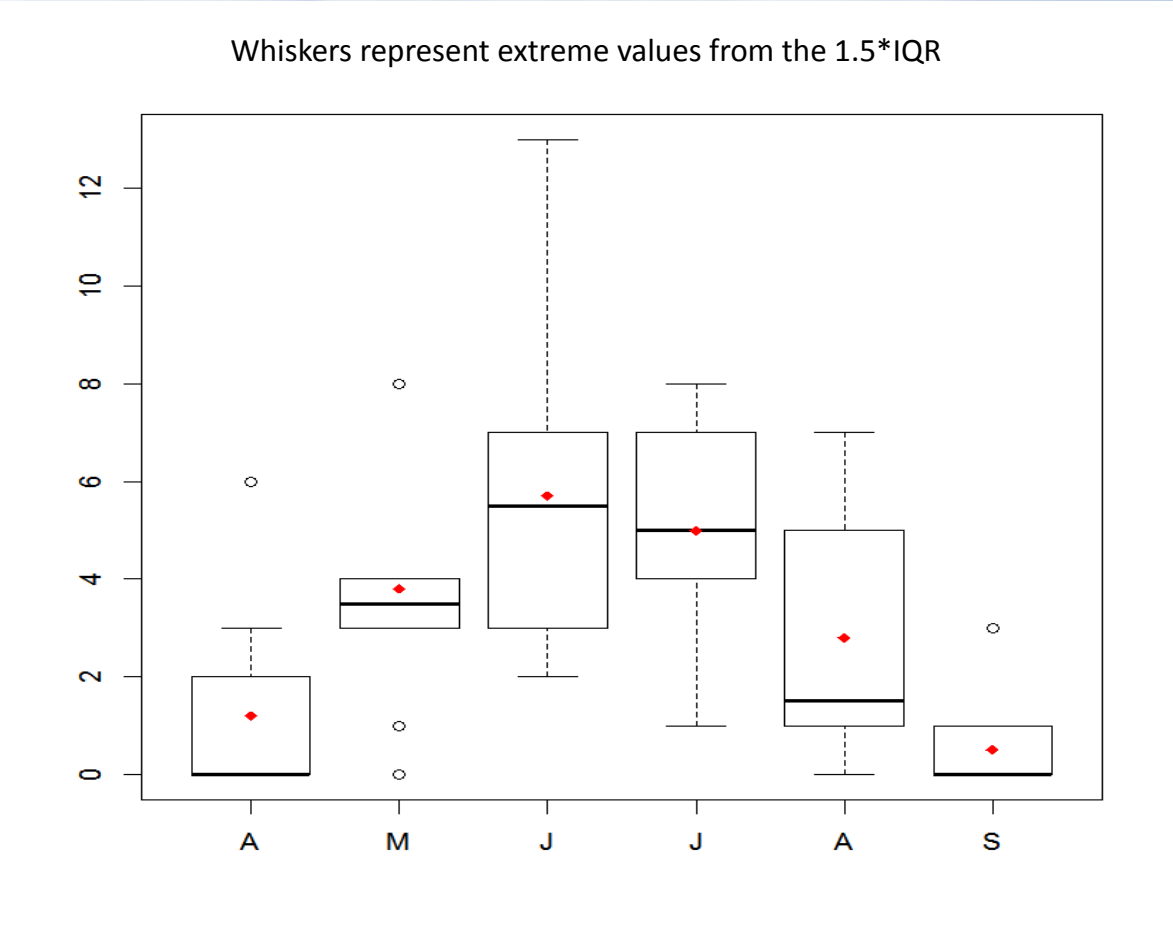


Hail day: at least one MAXPOH product has POH > 90% on > 0.1% of radar domain.

MAXPOH - hourly aggregation of 4 POH grids by maximum.

Seasonal distribution 2003 - 2012

Box-and-Whisker plot of number of hail days per month over 10 years (2003-2012).

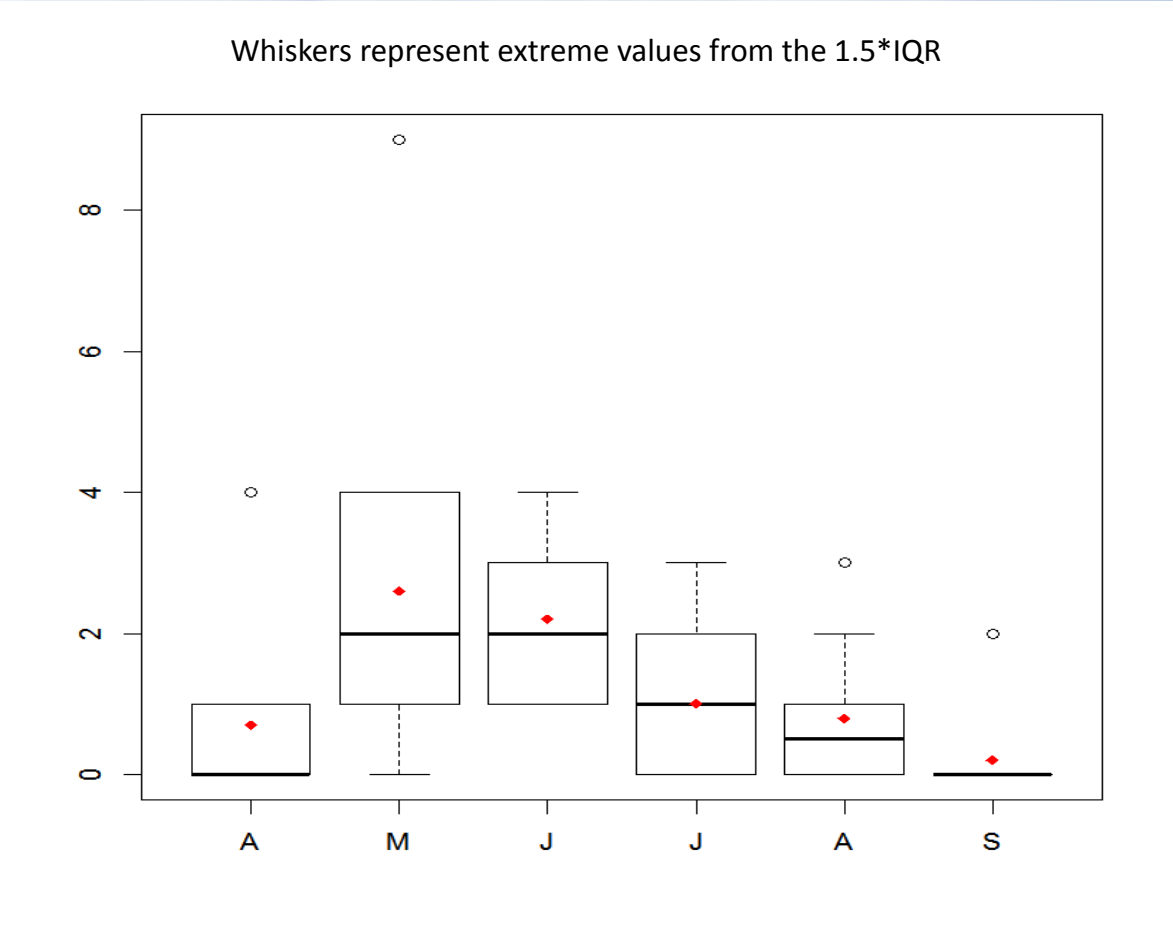


Hail day: at least one MAXPOH product has POH > 90% on > 0.1% of radar domain.

MAXPOH - hourly aggregation of 4 POH grids by maximum.

Seasonal distribution 2003 - 2012

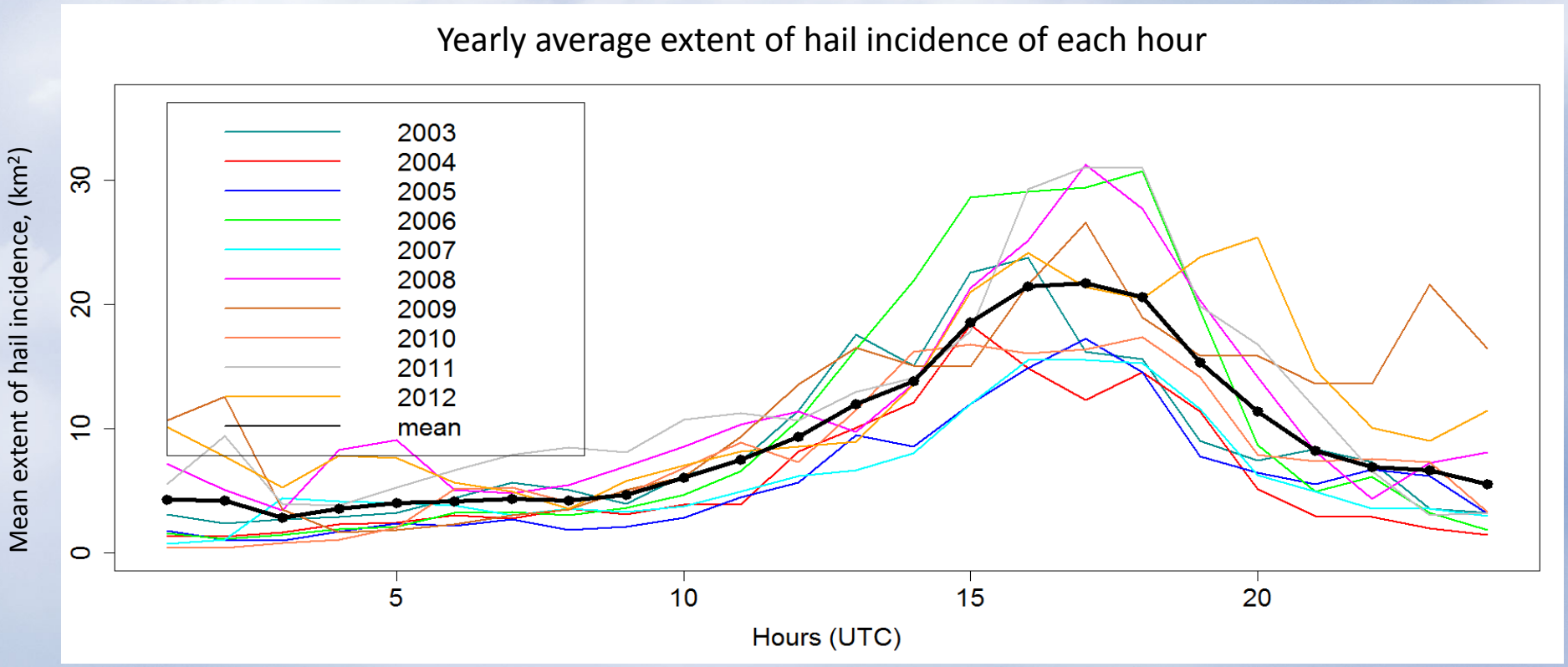
Box-and-Whisker plot of number of hail days per month over 10 years (2003-2012).



Hail day: at least one MAXPOSH product has POSH > 60% on > 0.1% of radar domain.

MAXPOSH - hourly aggregation of 4 POSH grids by maximum.

Diurnal cycle 2003 - 2012

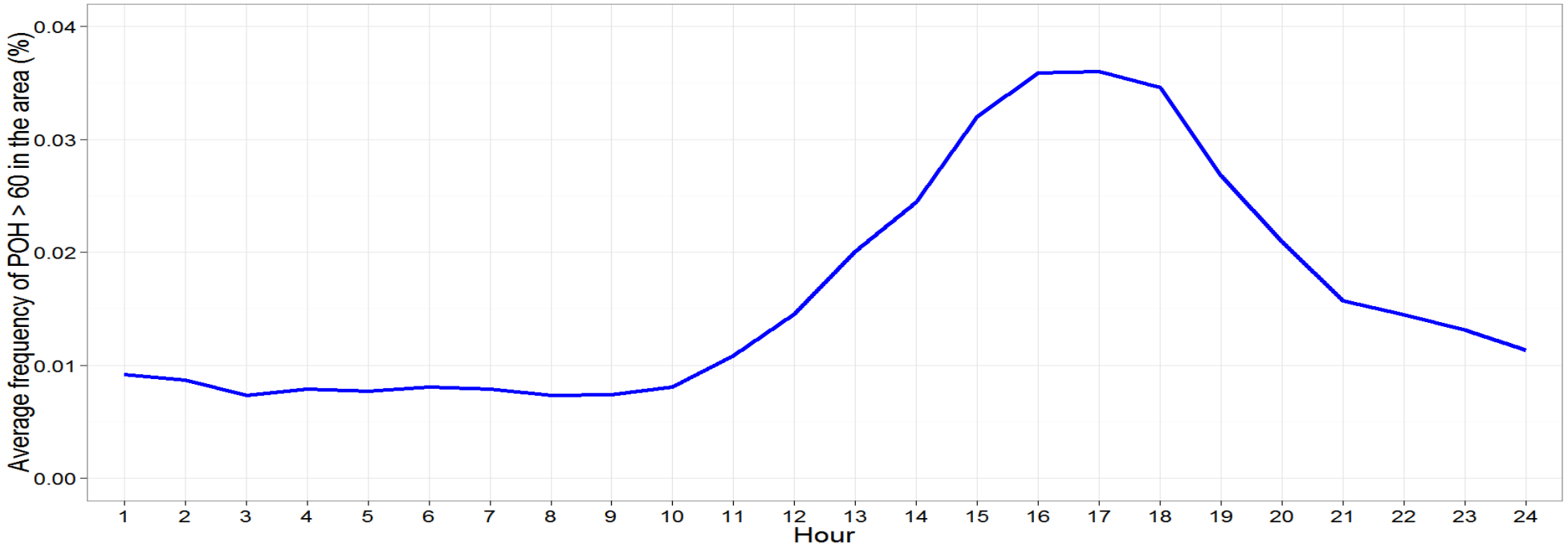


Hail detected with probability of hail (POH) > 90% criterion.

Analysis is based on 10 years of MAXPOH product of Wideumont radar (240 km range).
MAXPOH - hourly aggregation of 4 POH grids by maximum.

Diurnal cycle 2003 - 2012

Average frequency of hail incidence

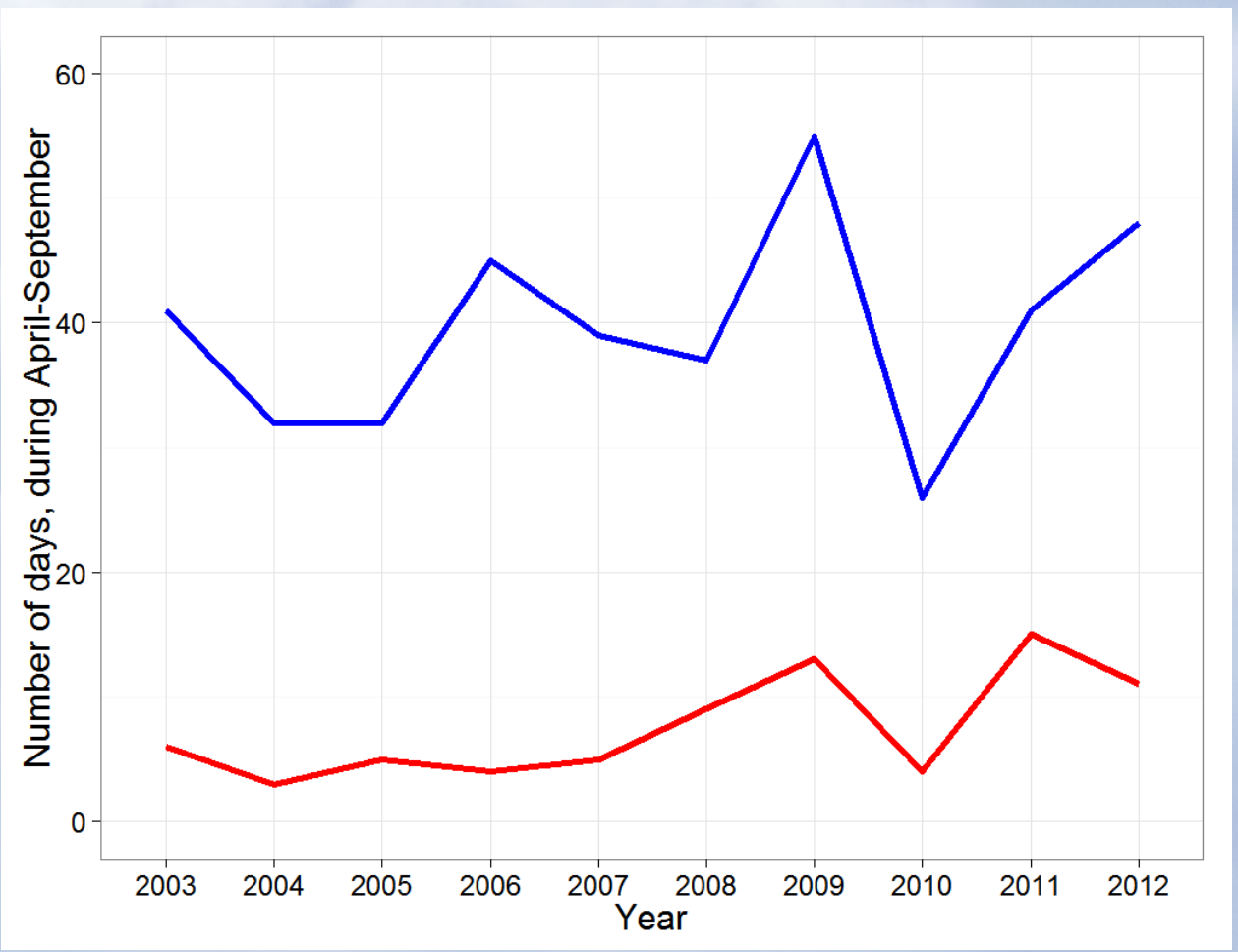


Hail detected with probability of hail (POH) > 60% criterion.

Analysis is based on 10 years of MAXPOH product of Wideumont radar (240 km range).
MAXPOH - hourly aggregation of 4 POH grids by maximum.

Diurnal cycle 2003 - 2012

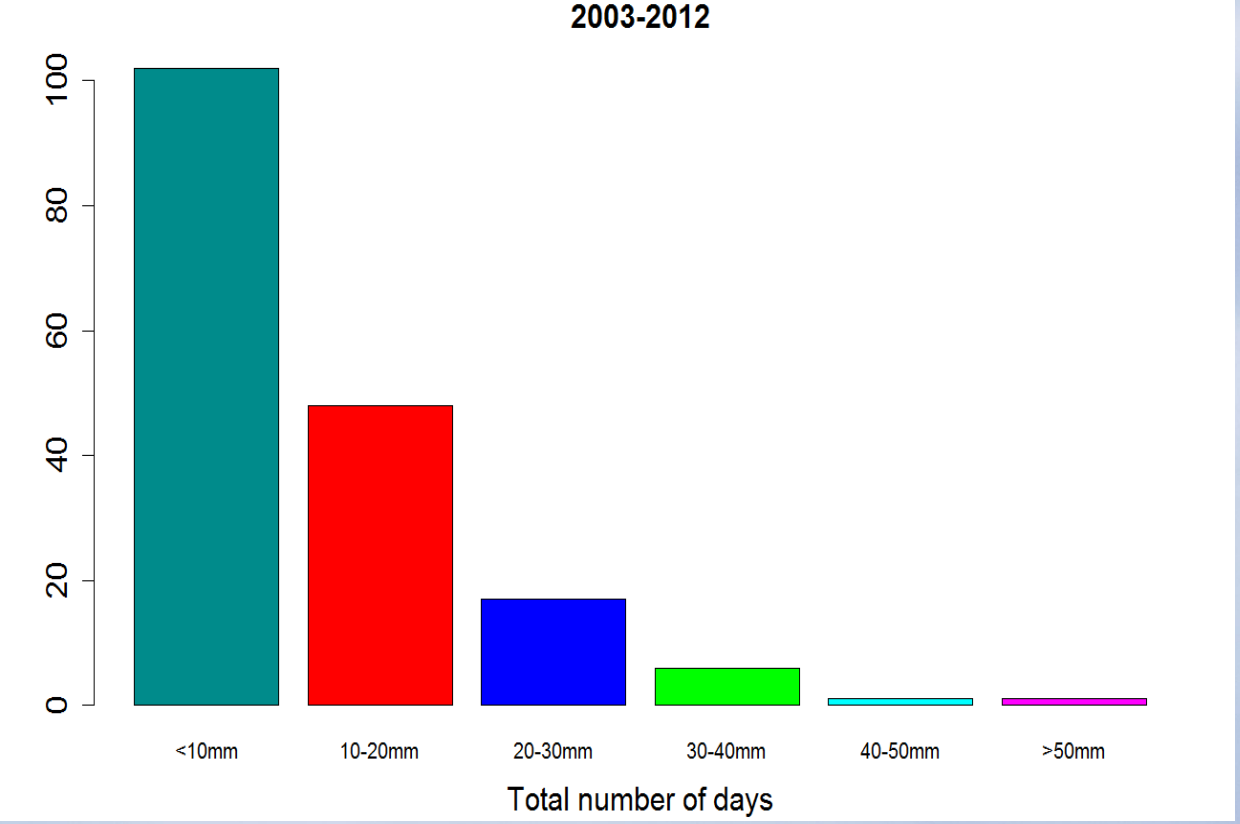
Number of hail days per year



Analysis is based on 10 years of MAXPOH product of Wideumont radar (240 km range).
MAXPOH - hourly aggregation of 4 POH grids by maximum.

MESH 2003 - 2012

Number of hail days per bin



Hail detected with probability of hail (POH) > 90% criterion.

Analysis is based on 10 years of MAXPOH product of Wideumont radar (240 km range).
MAXPOH - hourly aggregation of 4 POH grids by maximum.

Conclusions

Radar data and verified detection algorithms are a good source of hail statistics.

Ten years of data are enough to detect the diurnal cycle and seasonal distribution at least for the hail events of all sizes, but not enough for the detection of real climatology trends.

The work on the generation of the radar-based hail climatology is still ongoing …

Thank you!