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CLIMATE CHANGE RESEARCH

Spatial and temporal distribution of hailstorm in the Alpine region: a long-term, high resolution, radar-based analysis

Luca Nisi[1,2], Olivia Martius[1], Alessandro Hering[2], Urs Germann[2]

[1] Oeschger Centre for Climate Change Research, University of Bern, Zähringerstrasse 25, 3012 Bern, Switzerland
[2] Federal Office of Climatology and Meteorology MeteoSwiss, Via ai Monti 146, 6605 Locarno-Monti, Switzerland

luca.nisi@meteoswiss.ch

Outline

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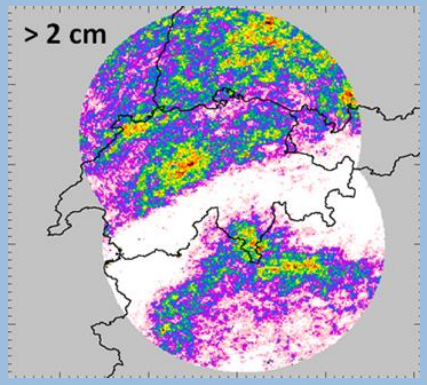
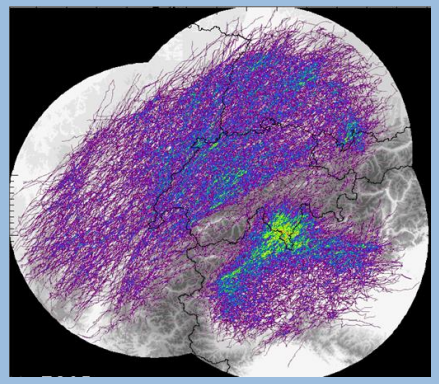
- Analysis of hailstorms over Switzerland and adjacent areas
  - ‘Gridded’ approach
  - ‘Object-based’ approach





- Nisi L, Martius O, Hering A, Germann U. 2016.
Spatial and temporal distribution of hailstorms in the Alpine region: A long-term, high resolution, radar-based analysis. QJRMS: accepted 17 Feb 2016, DOI: 10.1002/qj.2771.

- Schemm S, Nisi L, Martinov A., Leuenberger D., Martius O. 2016.
On the link between cold fronts and hail in Switzerland.
ASL: accepted 18 Mar 2016.

Single polarization hail algorithms

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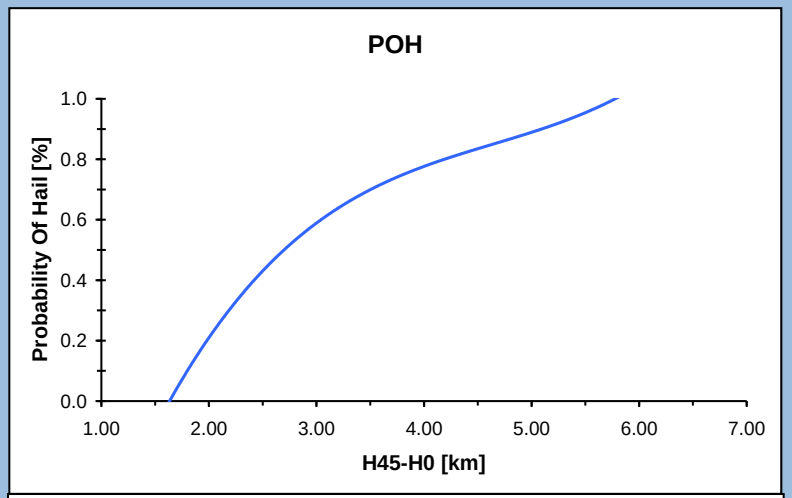
POH (***Foote et al., 2005*** based on ***Waldvogel et al.,1979***)

(**P**robability **O**f **H**ail)

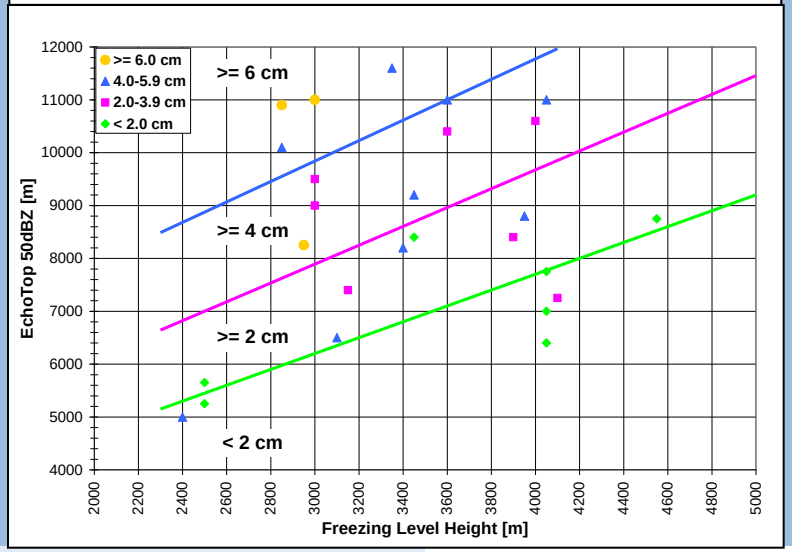
- $\Delta H = H_{45dBZ} - H_{0^\circ C}$
- Hail: $\Delta H \geq 1.6$ km
- 100%: $\Delta H \geq 5.8$ km



MESHS (***Joe et al., 2004*** based on ***Treloar, 1998***)

(**M**aximum **E**xpected **S**evere **H**ail **S**ize)

- H_{50dBZ}
- $H_{0^\circ C}$
- Hail **size ≥ 2.0 cm** from **Treloar nomogram**



Single polarization hail detection methods

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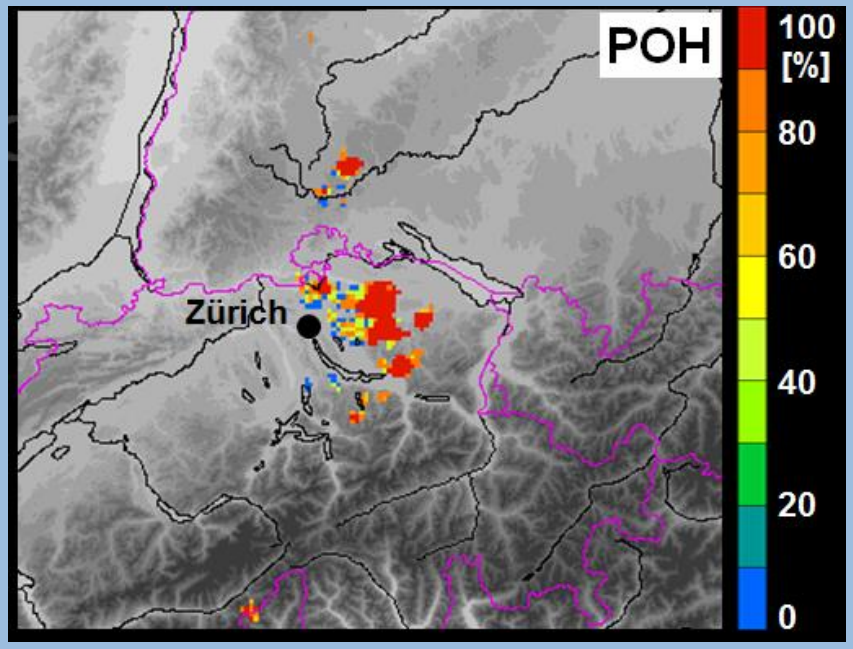
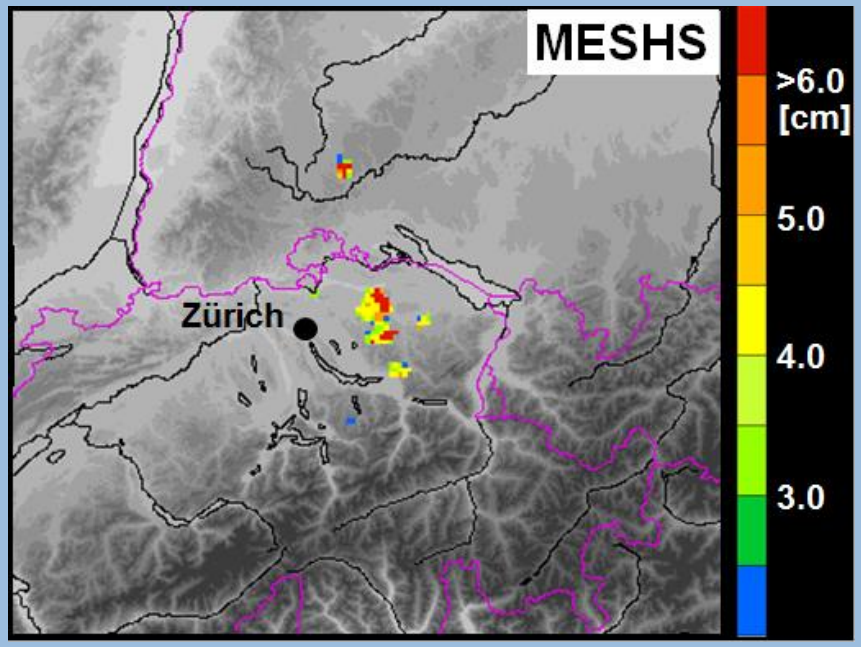


'Probability to have hail on the ground'



'Maximal hailstome size expected on the ground'

Reprocessing strategy (2002-2015)

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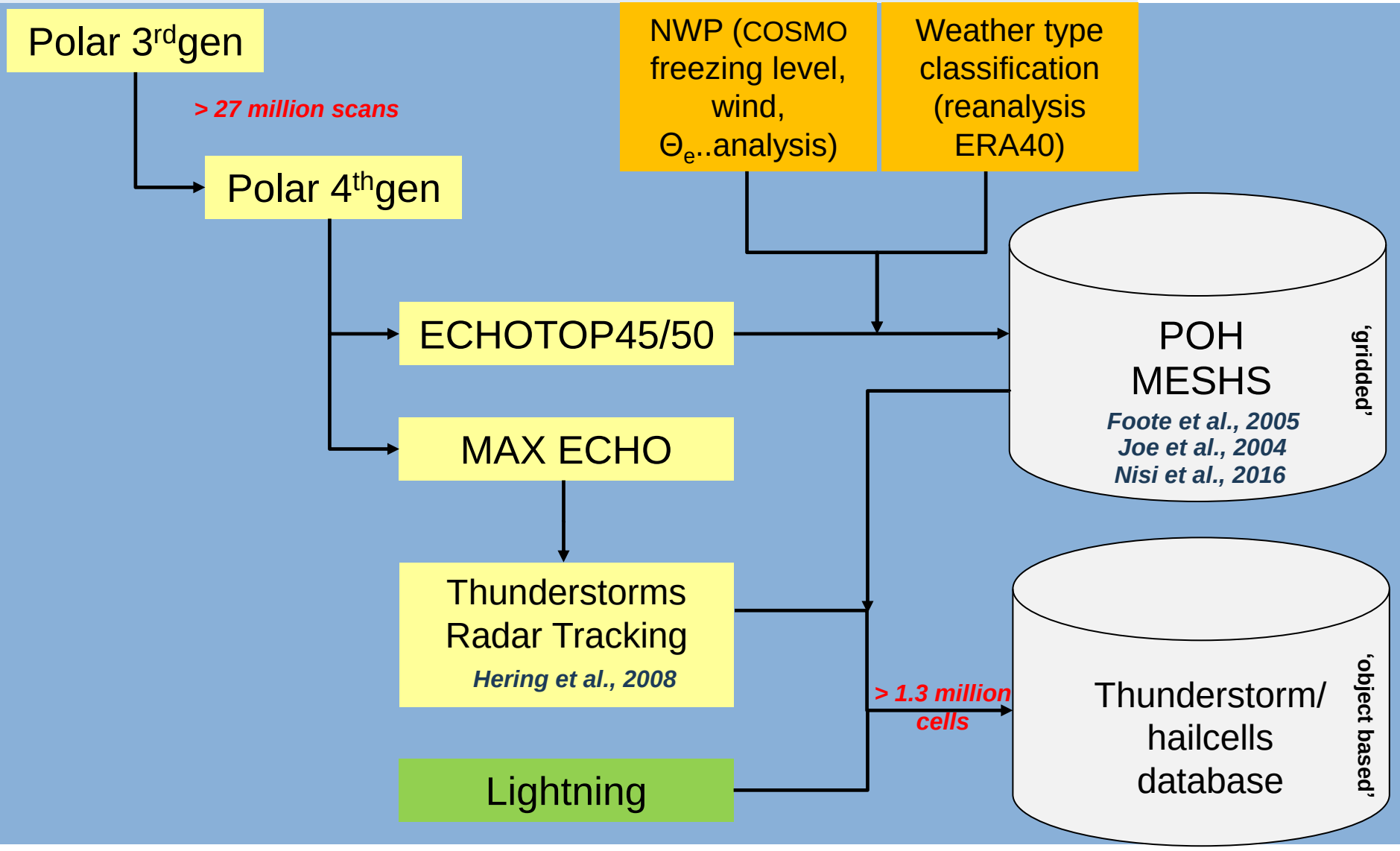

Domain

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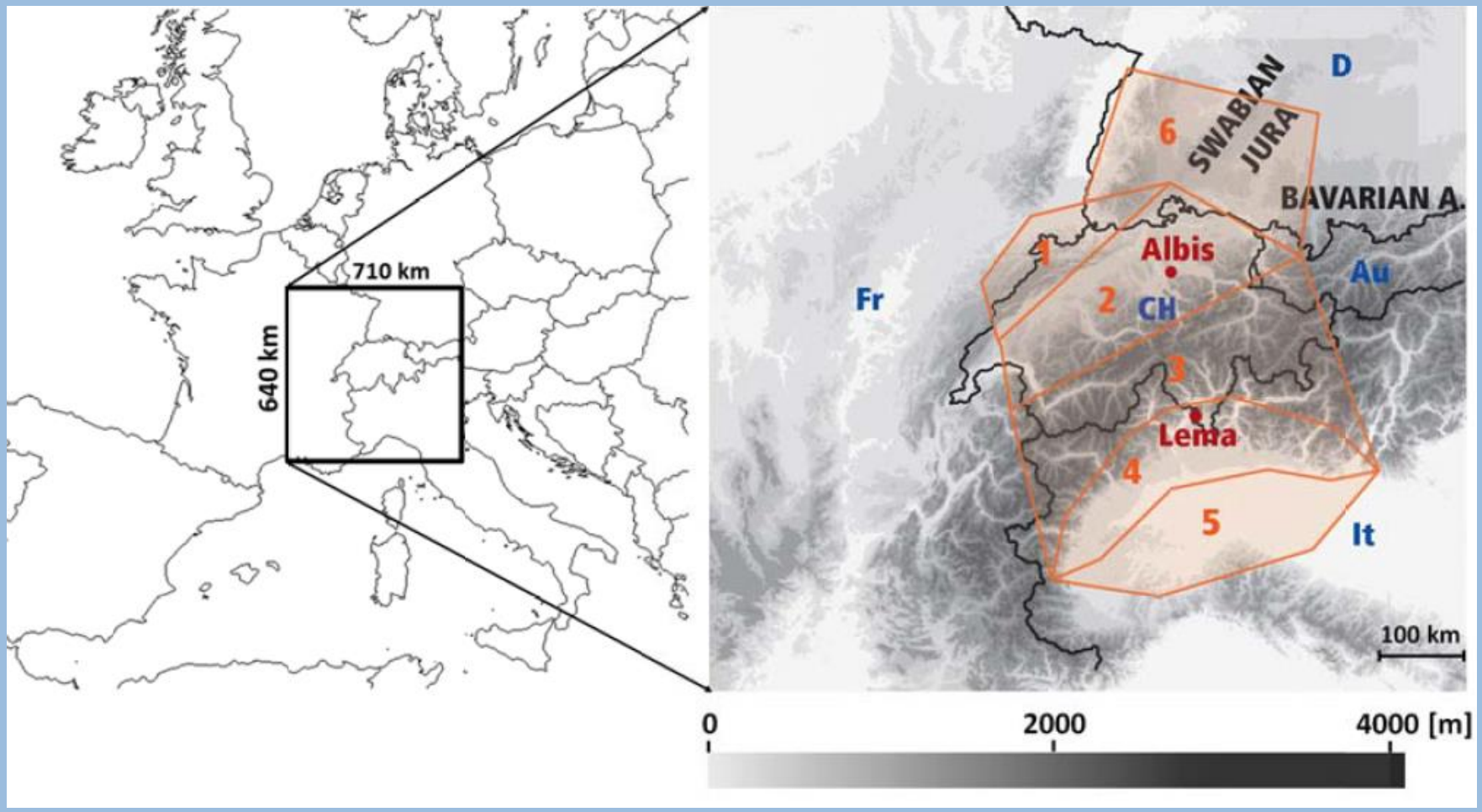

Using radar based approaches in the Alps

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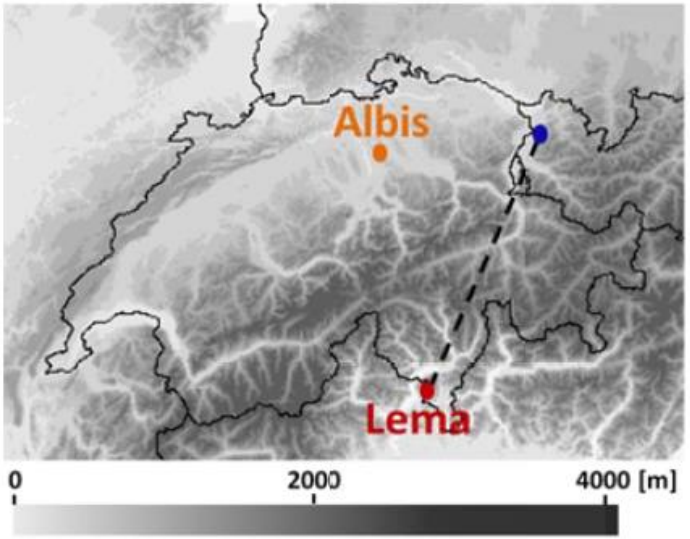

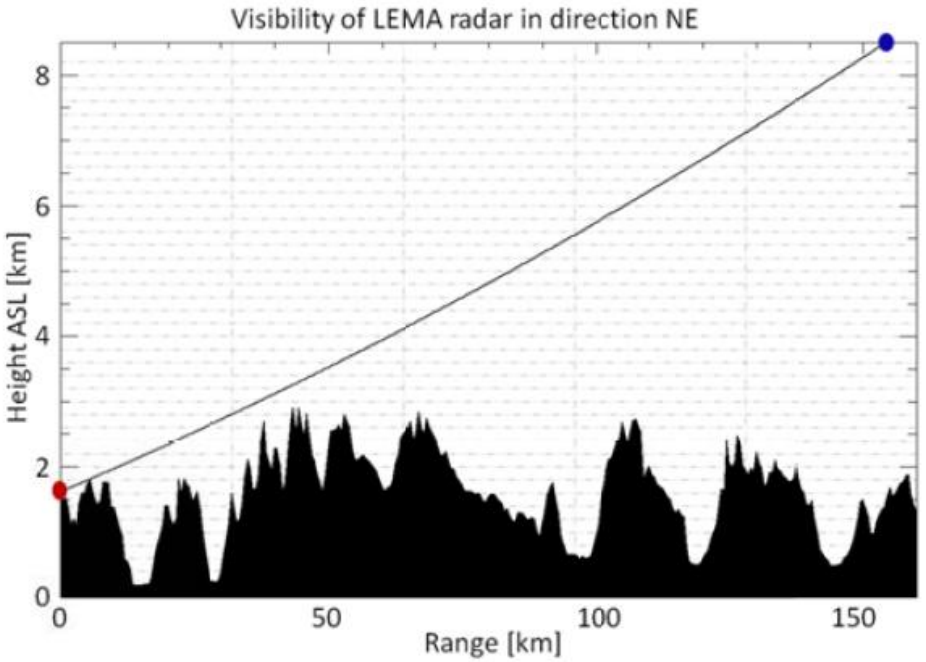

Figure 3: In the direction of NNE the beam of Lema radar is severely shielded by a nearby mountain. At a distance of 150 km the radar can observe precipitation only at a height of 8 km and higher. This is the direction with most severe shielding. The position of the Albis radar is also shown.

Climatological frequency (2002 – 2015)

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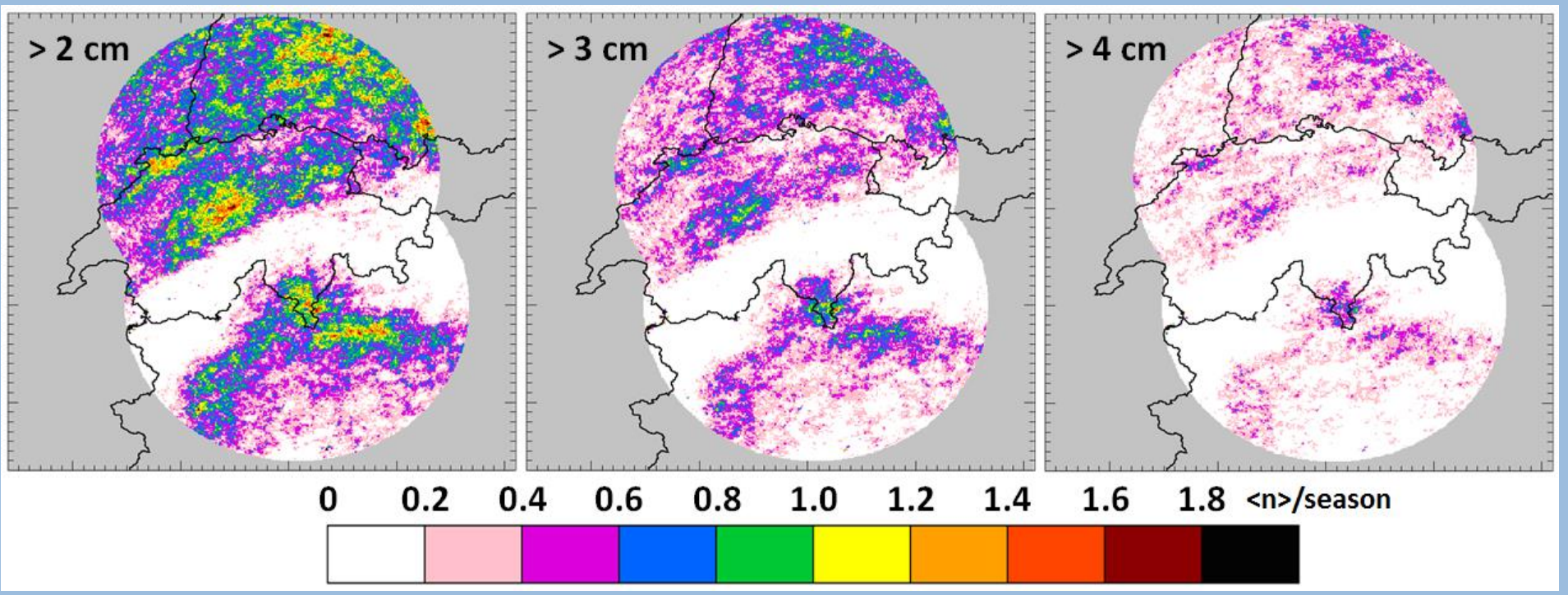
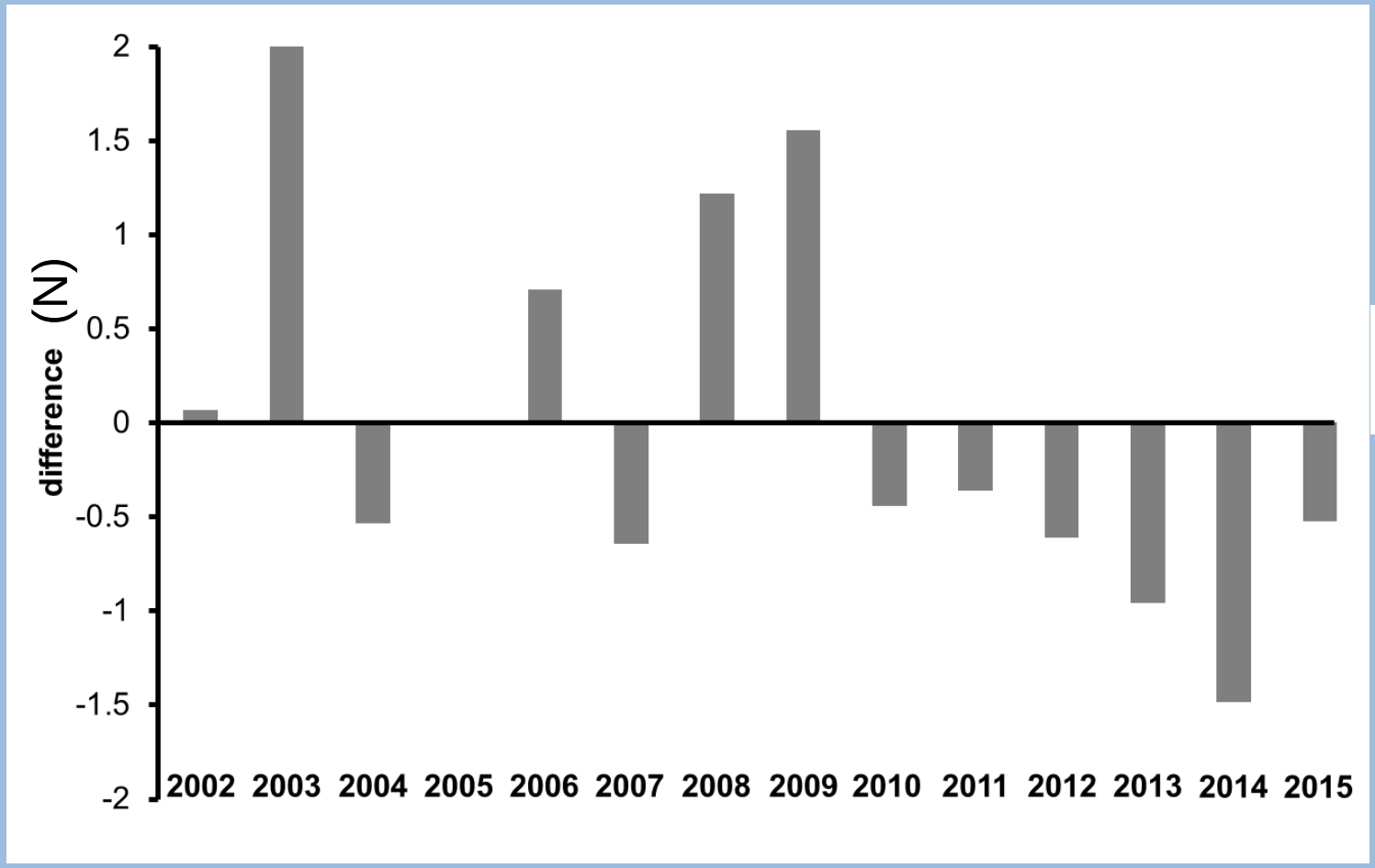


Yearly hail anomalies



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Hail mean frequency

Hail frequency i-year

$$N = \frac{p_i - \mu}{\sigma}$$

(Wilks, 2006)

STDDEV

Monthly distribution (2002 – 2015)

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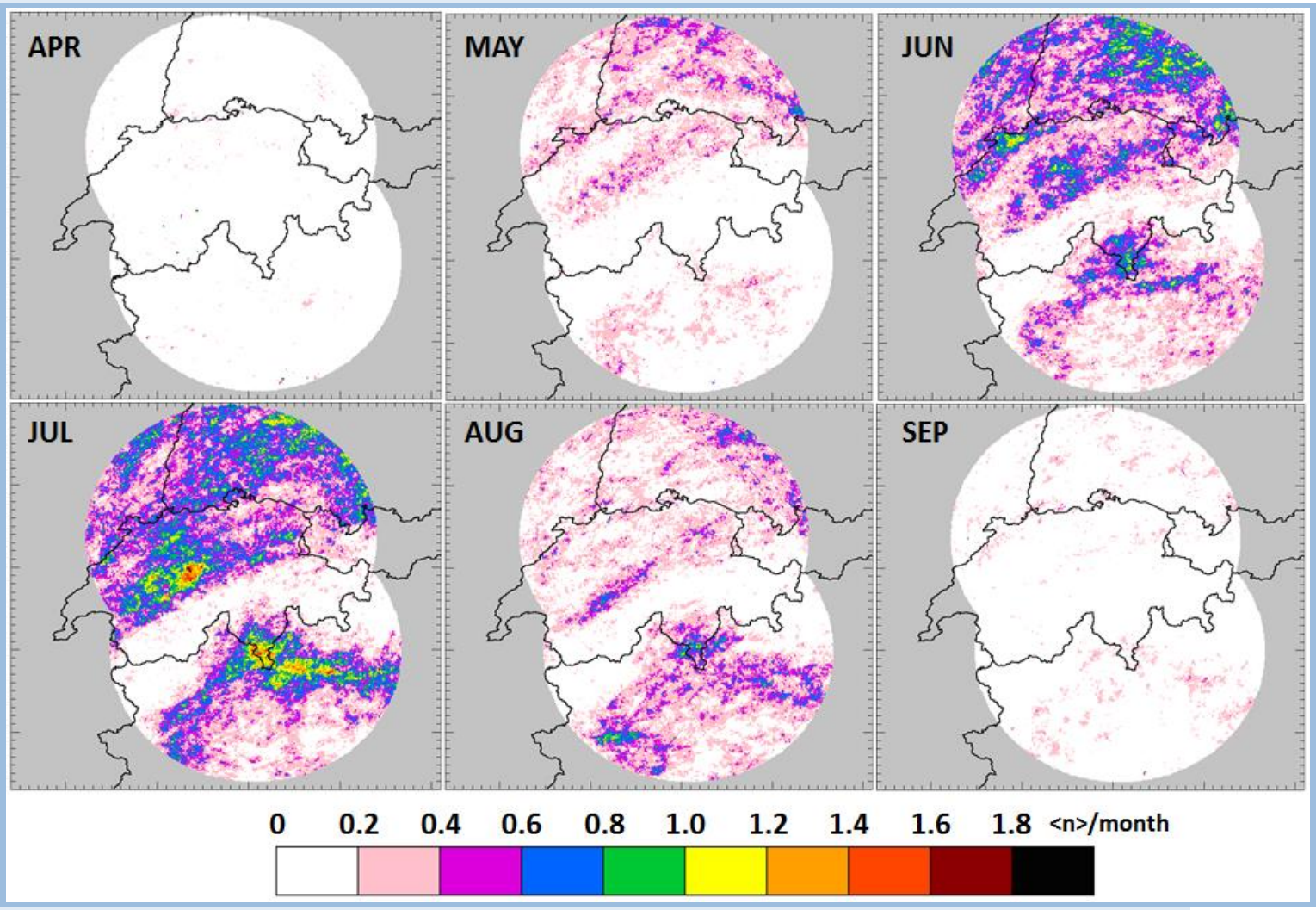

Weather type classification

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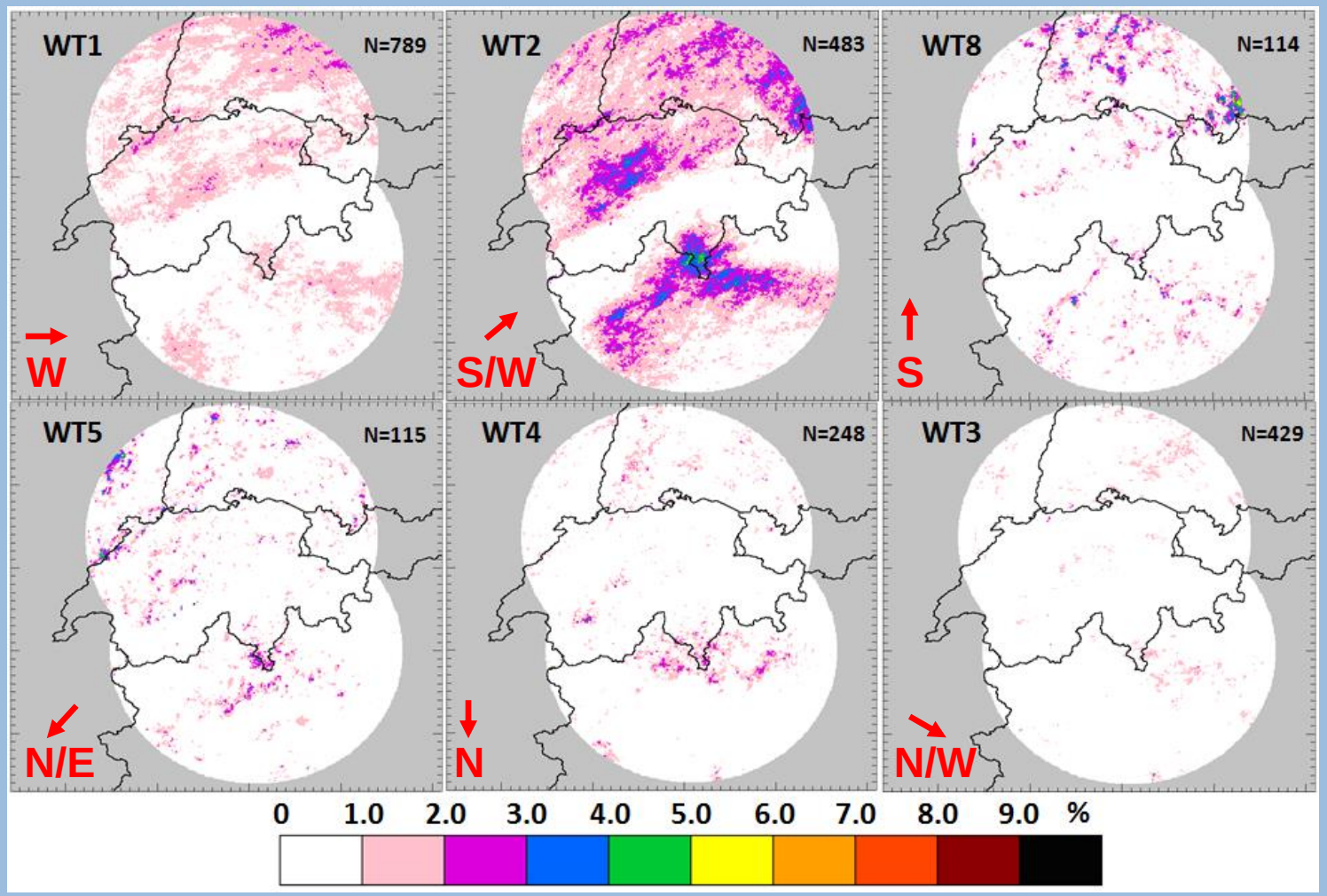

Diurnal hail max frequency (2002 – 2015)

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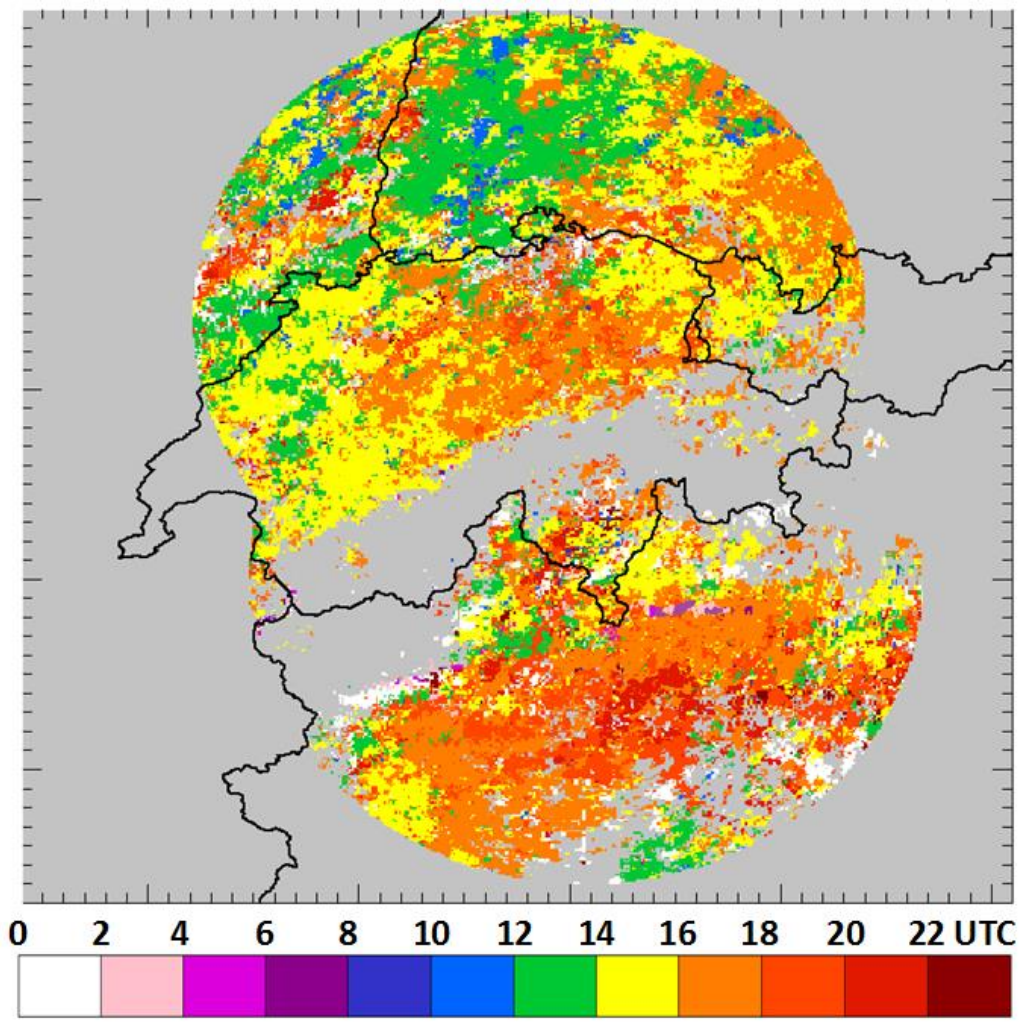

Time (UTC) of the highest radar-derived hail frequency per km2 for the period April-September 2002 – 2015.

Hailstorm trajectories frequency

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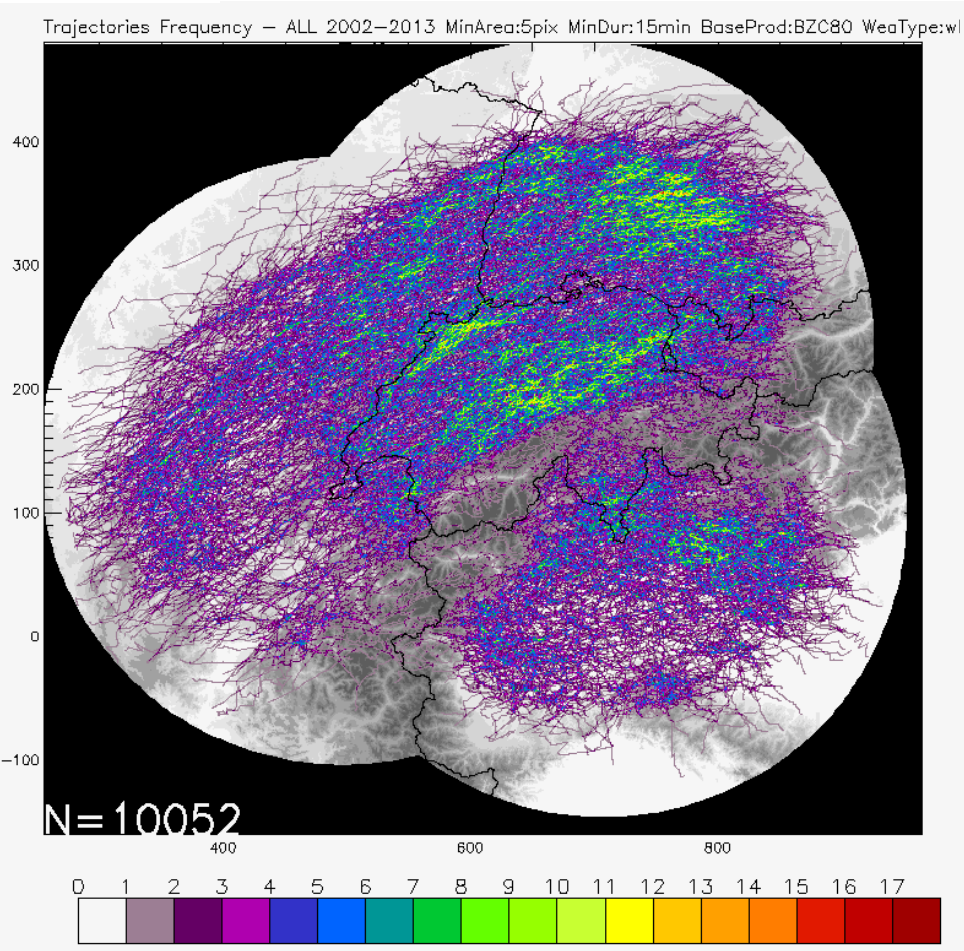
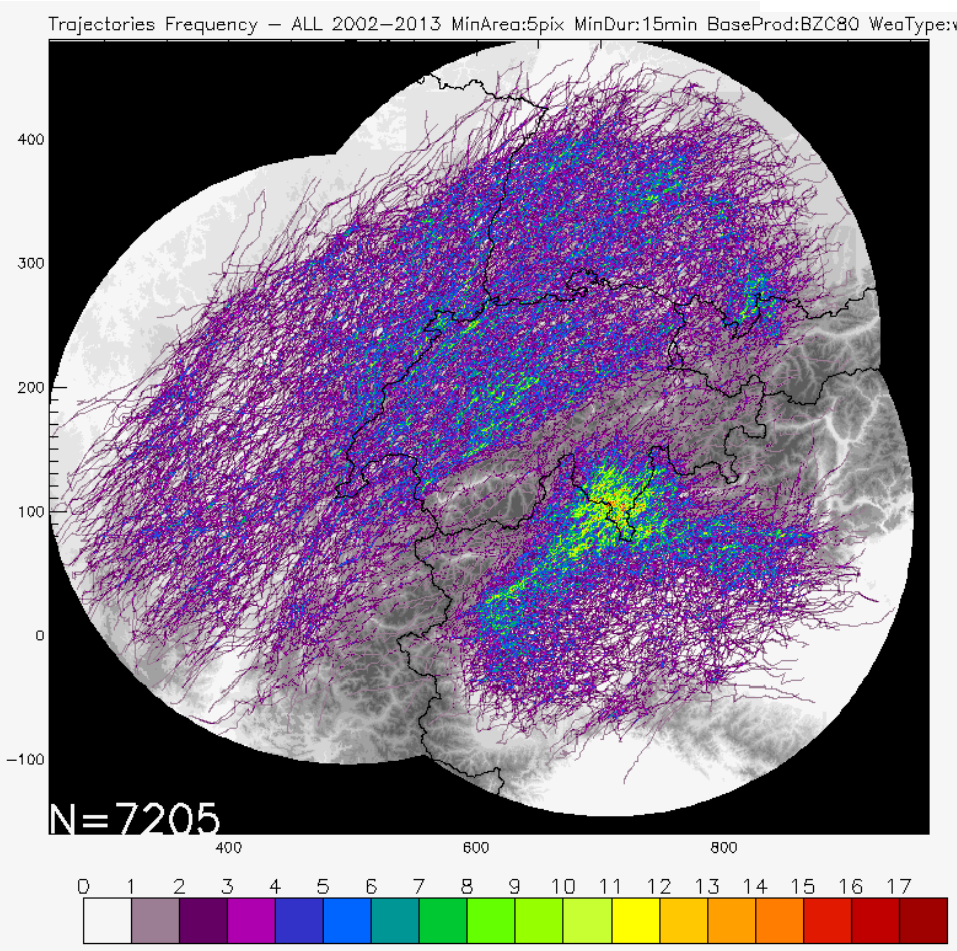
2002-2013, POH>80%: cell tracking + weather type classification (Weustoff, 2011)

W flow @ 500hPa



S/W flow @ 500hPa



Synoptic forcing

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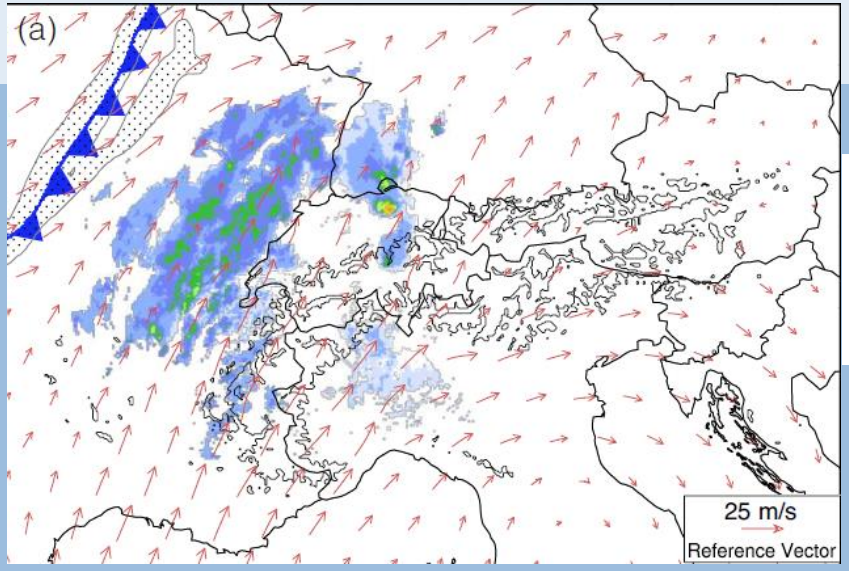
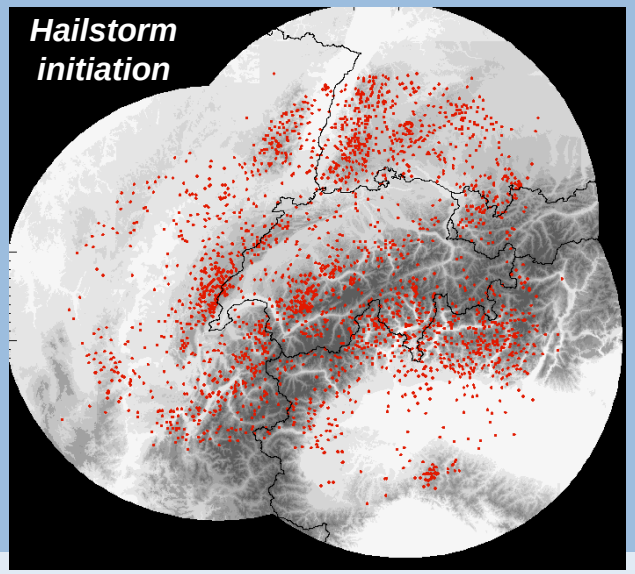


$$\mathrm{TFP} = -\nabla|\nabla\theta_e| \cdot \frac{\nabla\theta_e}{|\nabla\theta_e|}$$

('Thermal Front Parameter' Hewson, 1998)

+



30 - 45% of hailstorm initiation occur in pre-frontal environment

(Schemm et al., 2016)

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Lightning

Lightning homogeneity

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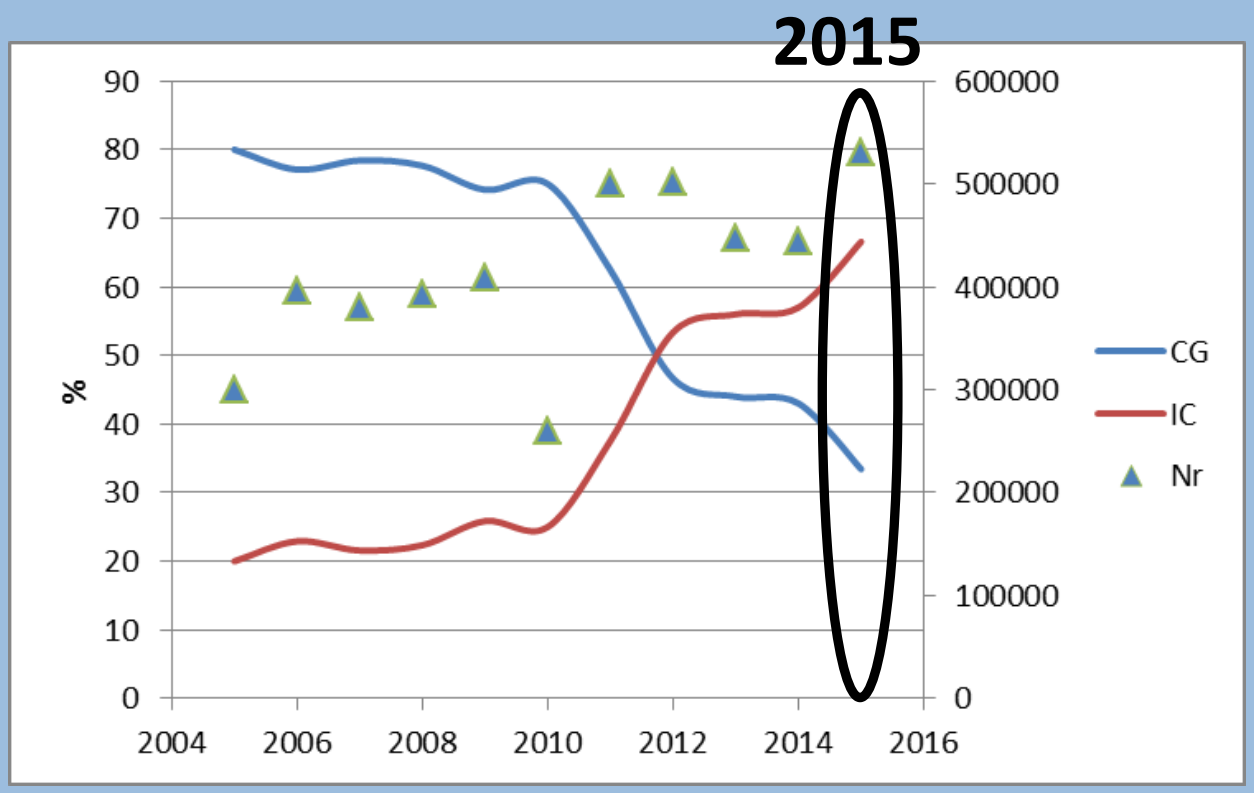
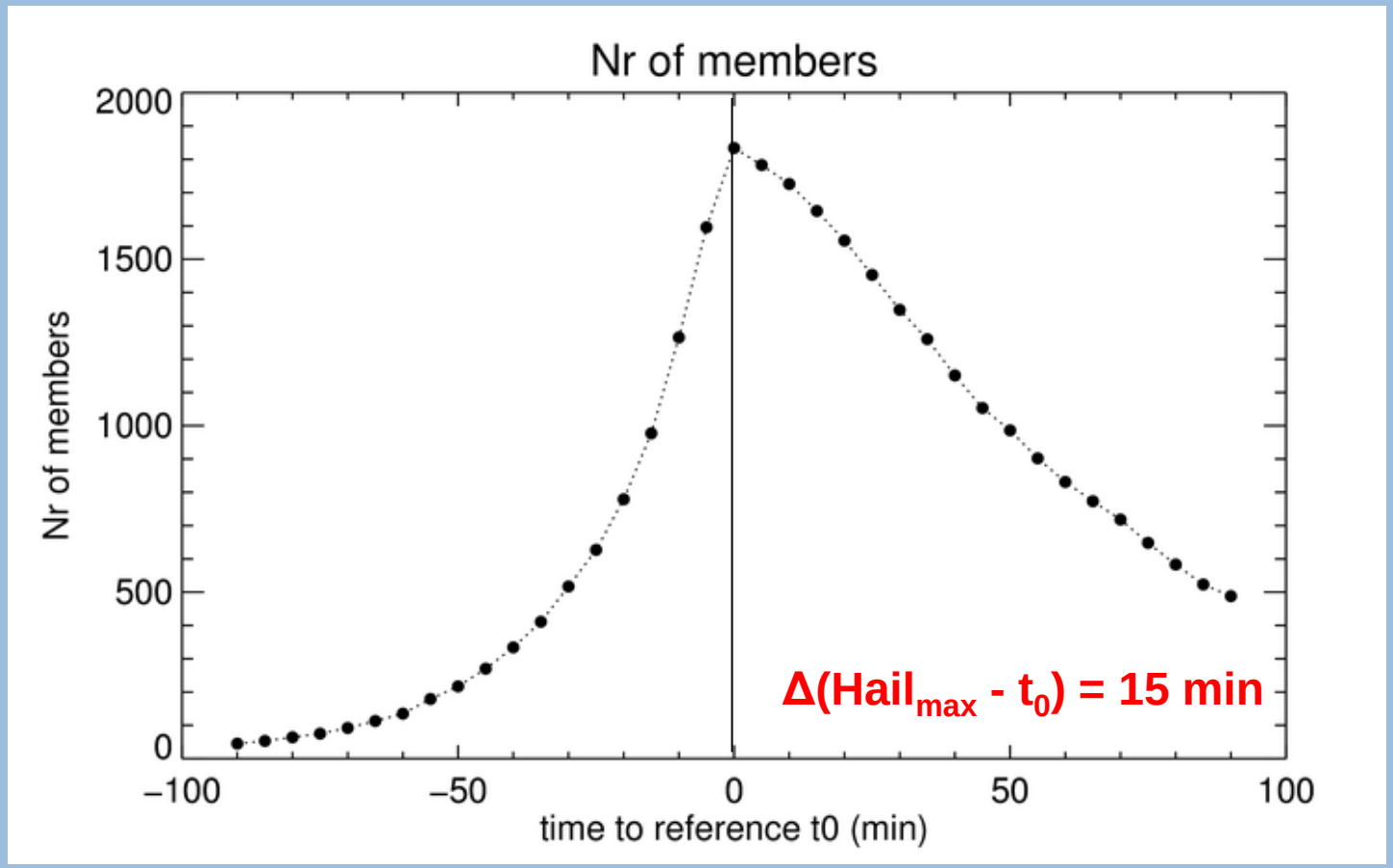


- Hardware / software upgrades (?)

Lightning (2015)

t_0 : hail initiation (POH: 80%)



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Lightning (2015)

t_0 : hail initiation (POH: 80%)

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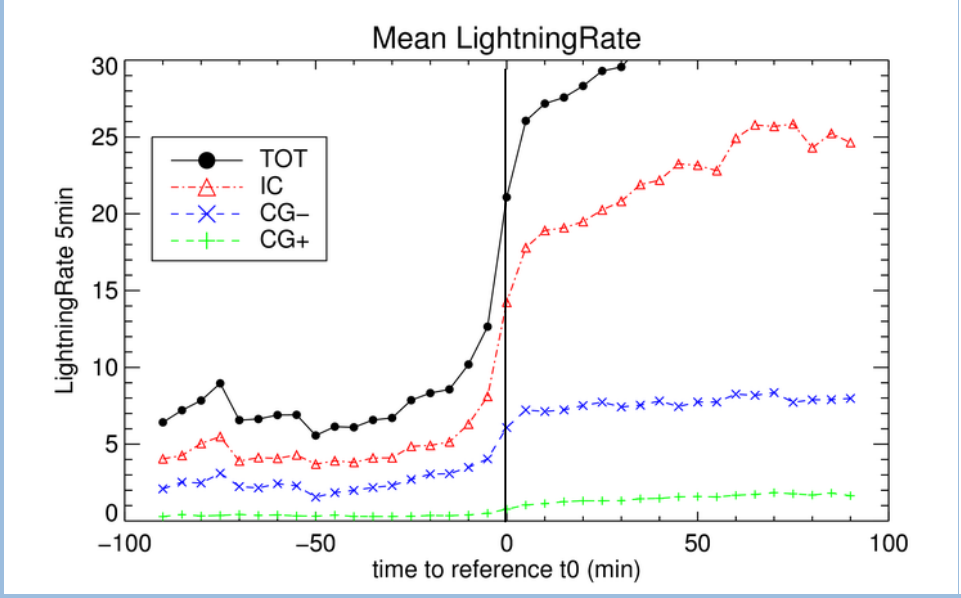
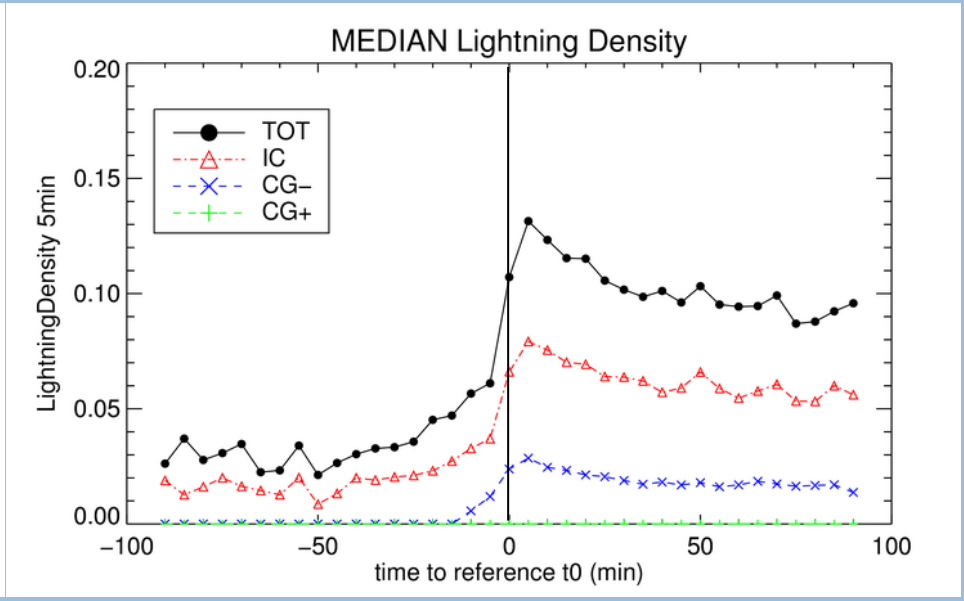
$\Delta(Hail_{max} - t_0) = 15$ min





Lightning density = TotNrLightning/CellArea

Lightning (2015)

t_0 : hail initiation (POH: 80%)

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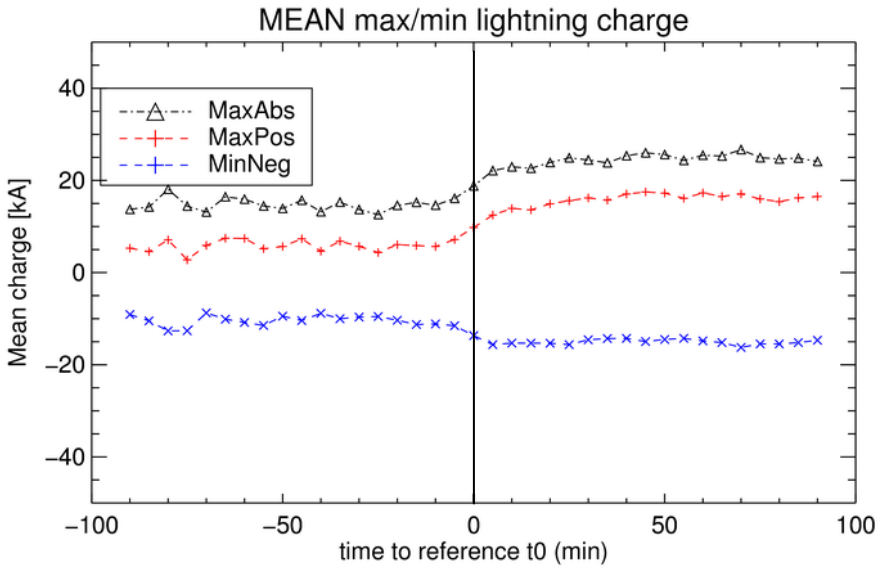
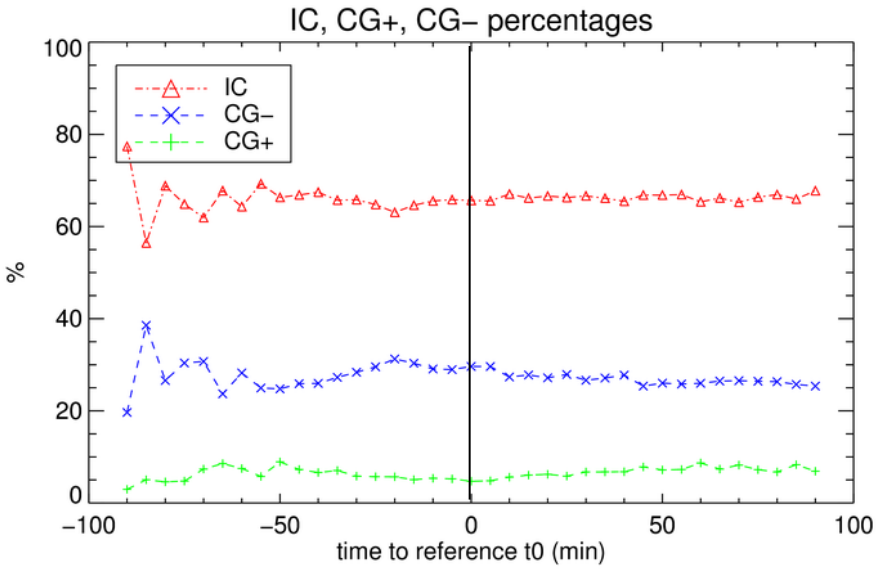
$\Delta(Hail_{max} - t_0) = 15$ min





Outlook

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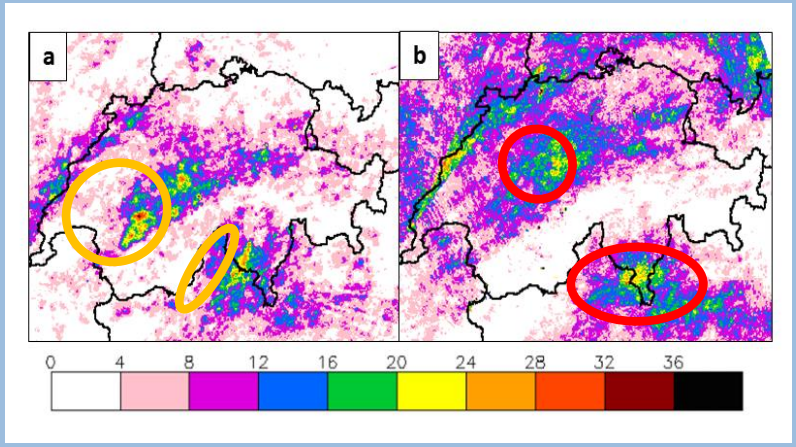
- Statistics on:

  - hail/no-hail cells trajectory characteristics
  - 4D radar using VIL, SAT(?)

- intensification, initiation, hotspots vs. orography



- Investigate the potential for operational Nowcasting purposes

References

Thank you for you attention!

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Verification

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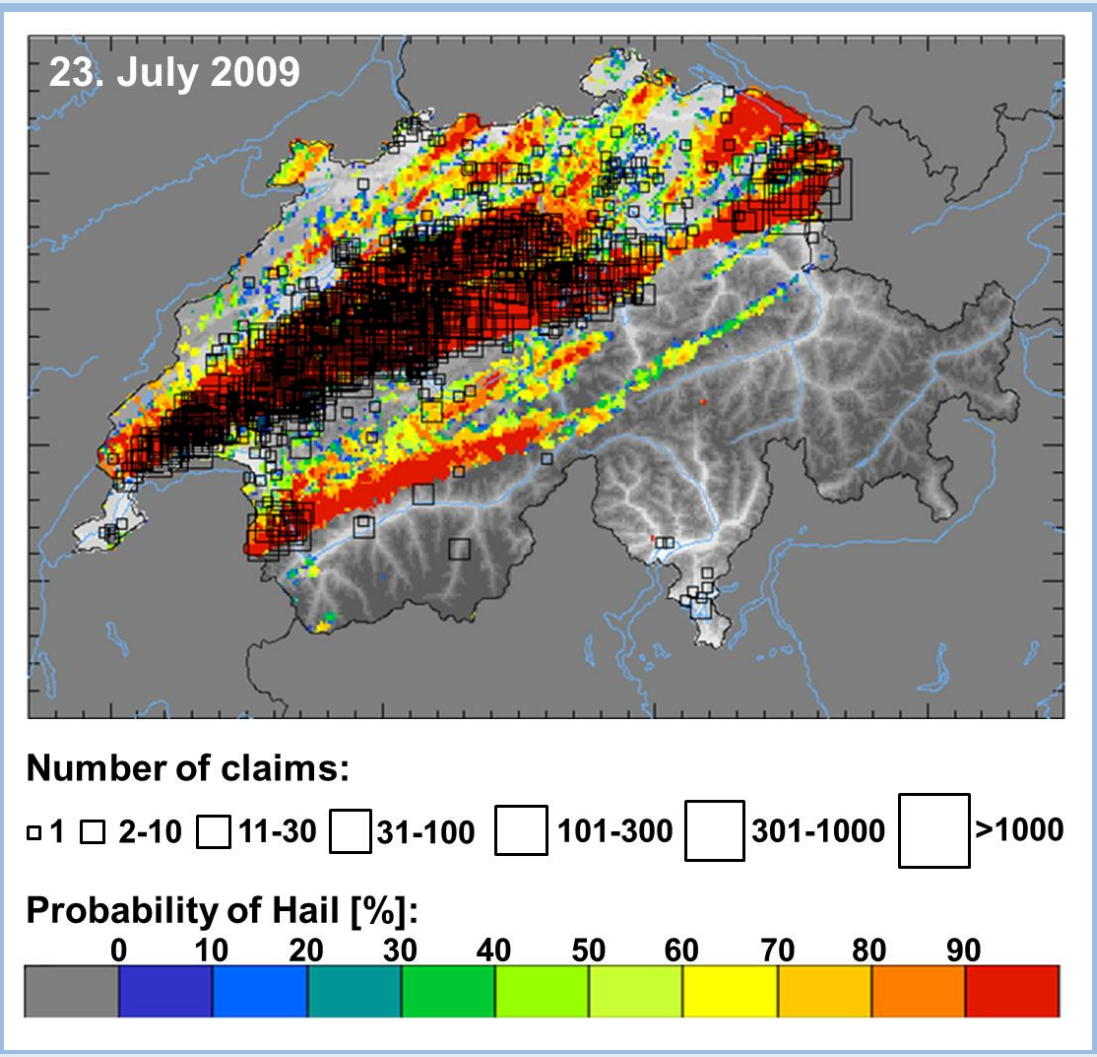

Verification

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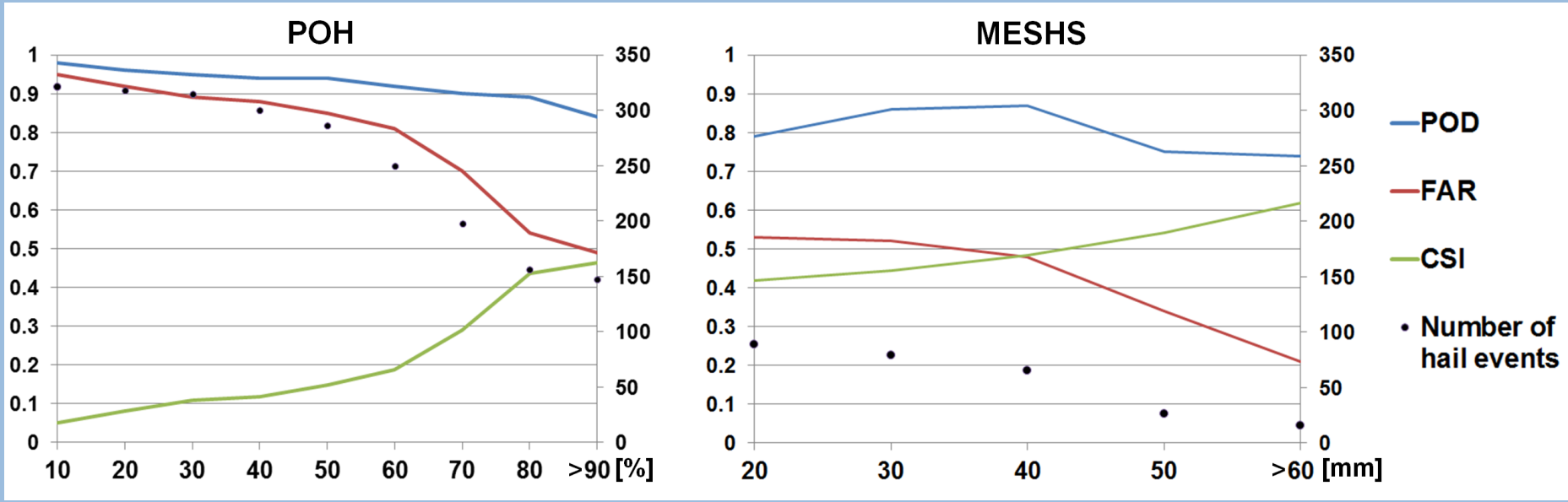
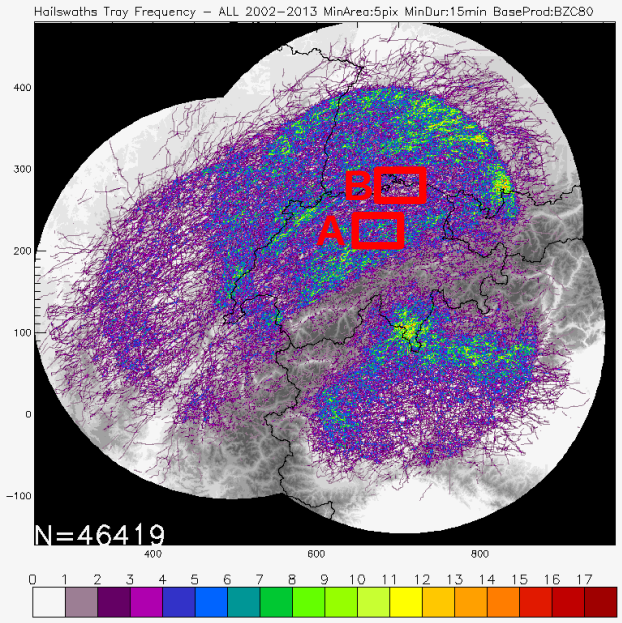
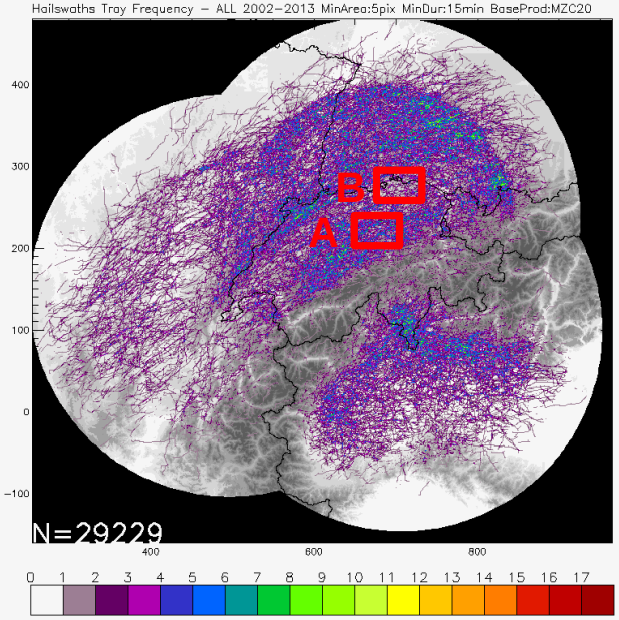


Hailswath frequency (2002-2013)

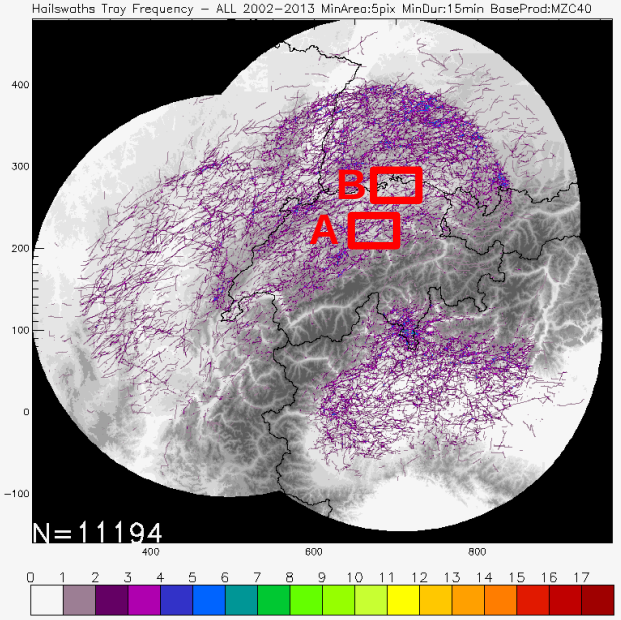
POH>80%



MESHS>2cm



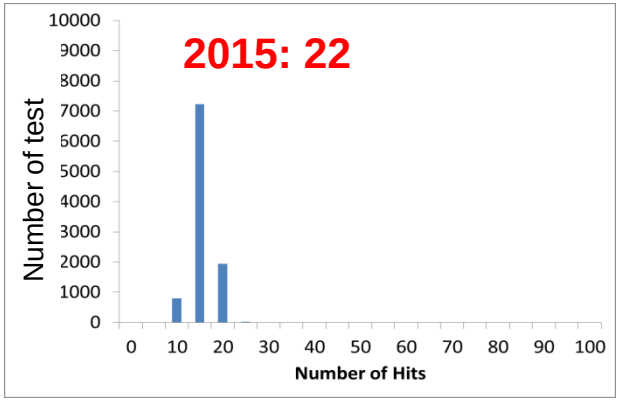
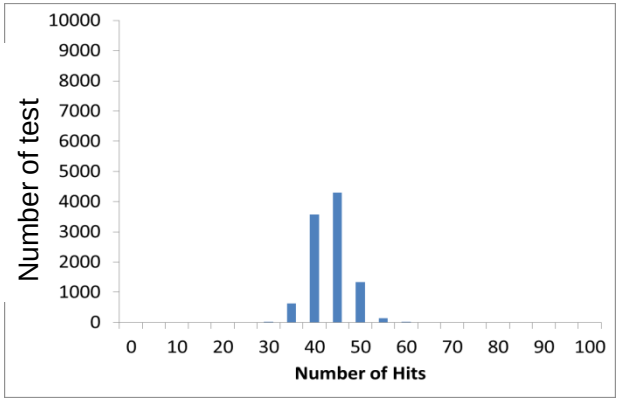
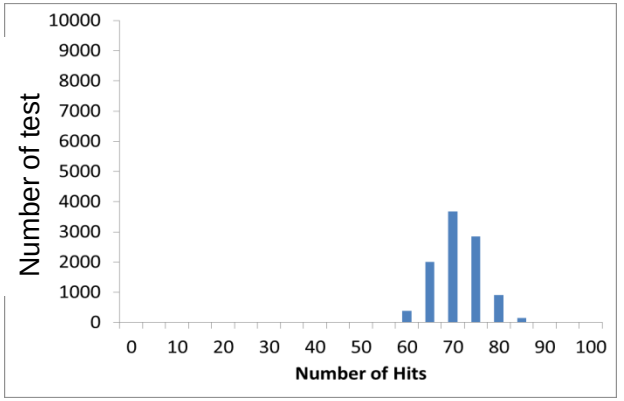
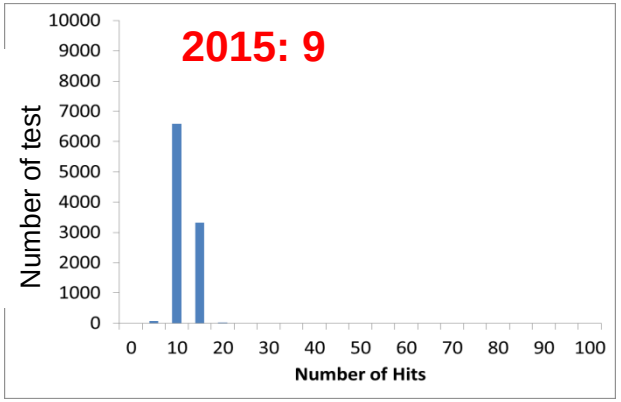
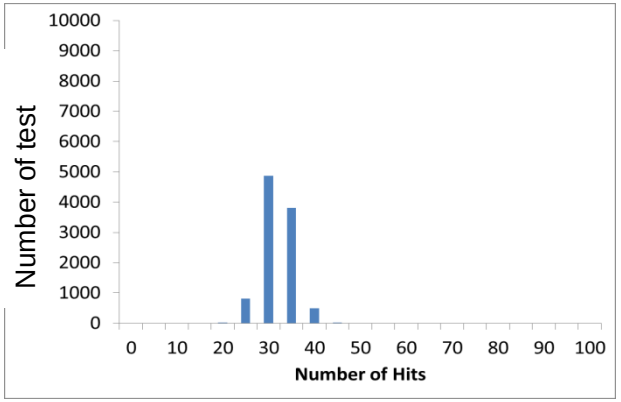
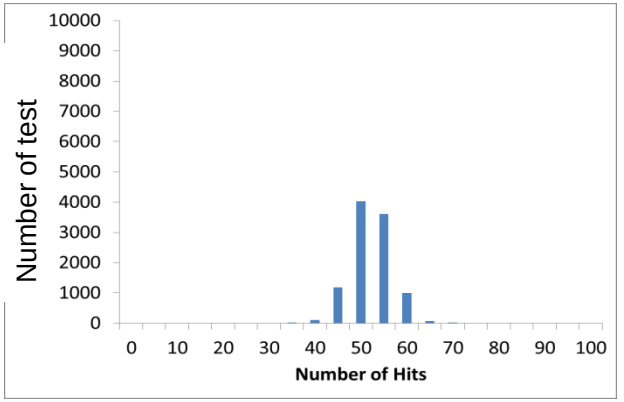
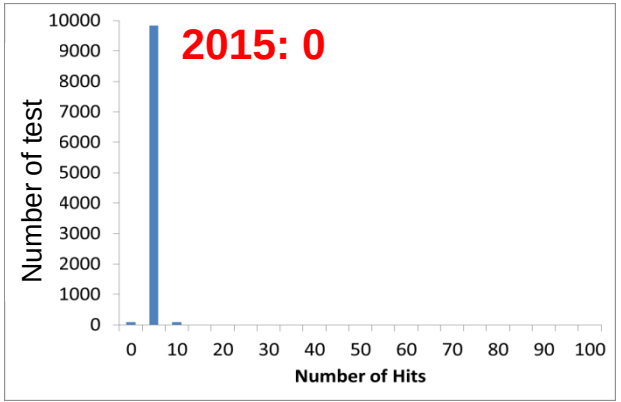
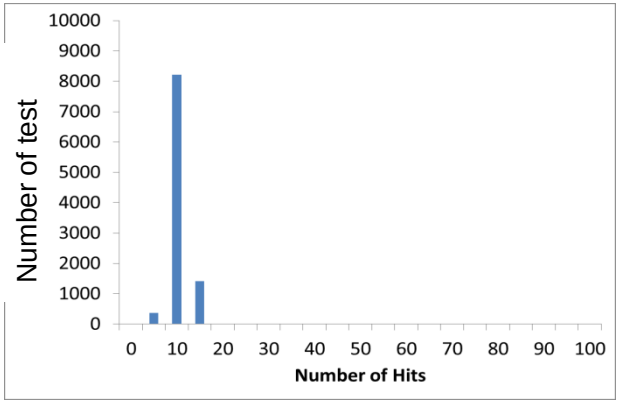
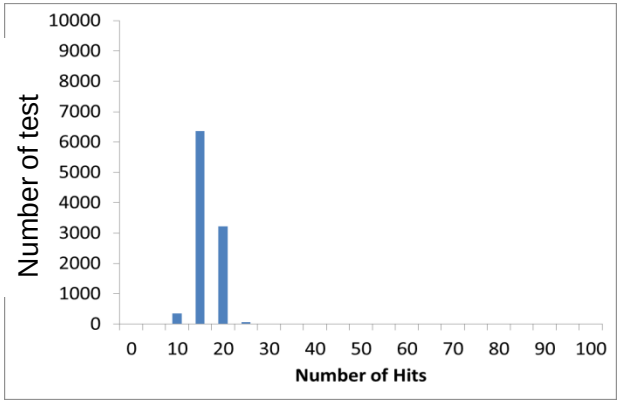
MESHS>4cm



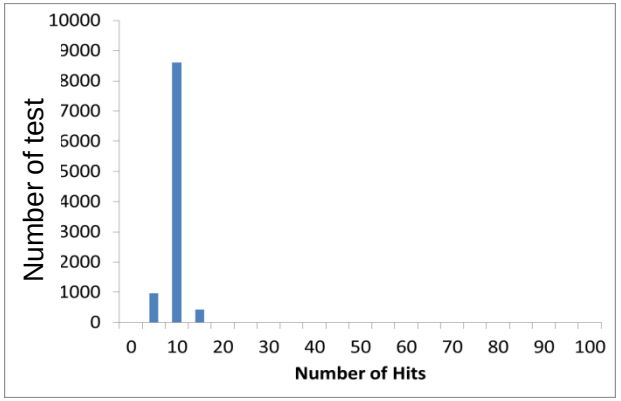
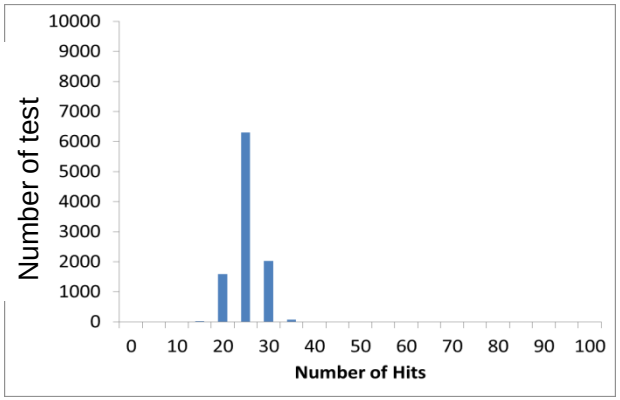
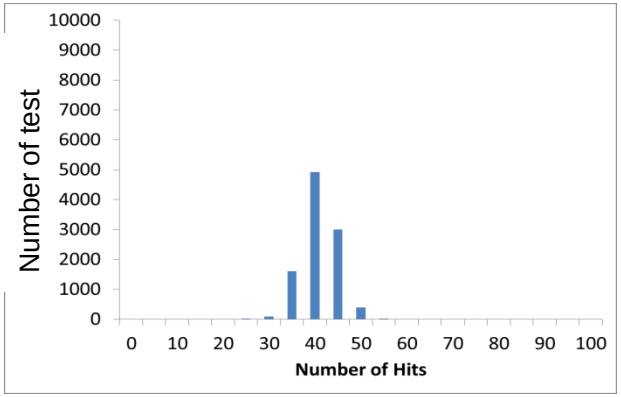
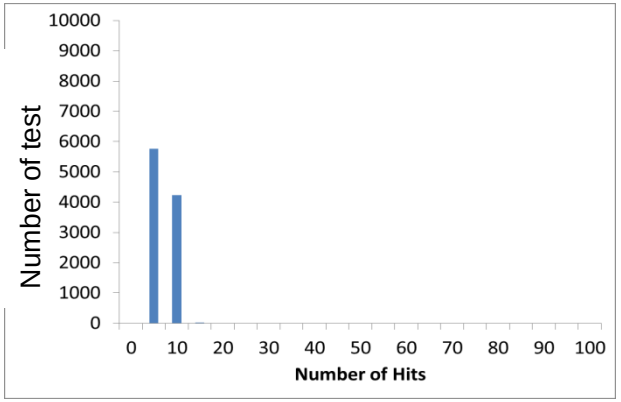
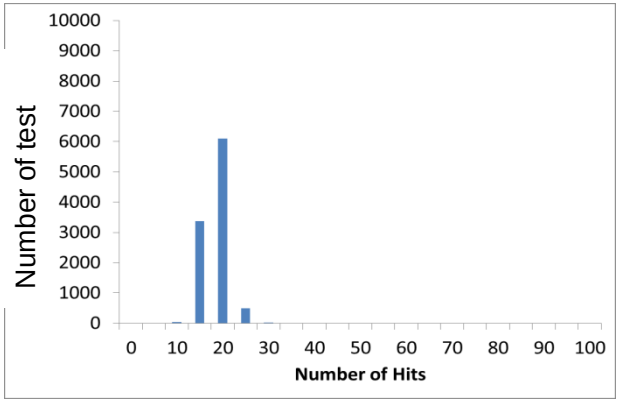
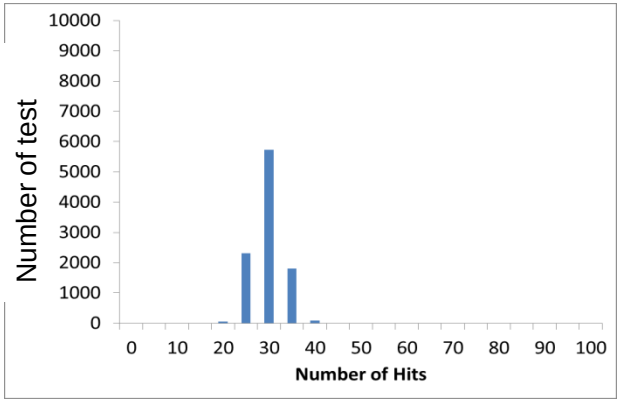
Please note: Hailswath frequency only, NOT considering the whole TRT trajectory !!!

N: number of hailswaths. One TRT trajectory can cointain more than one hailswath (e.g. re-invigoration) !!!

Results: region A (Luzern)

	10 detectors	30 detectors	50 detectors
POH>80%			
MESHS>2cm			
MESHS>4cm			

Results: region B (Thurgau)

	10 detectors	30 detectors	50 detectors
POH>80%			
MESHS>2cm			
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