Hail detection by means of a polarimetric hydrometeor classification algorithm

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ÉCOLE POLYTECHNIQUE
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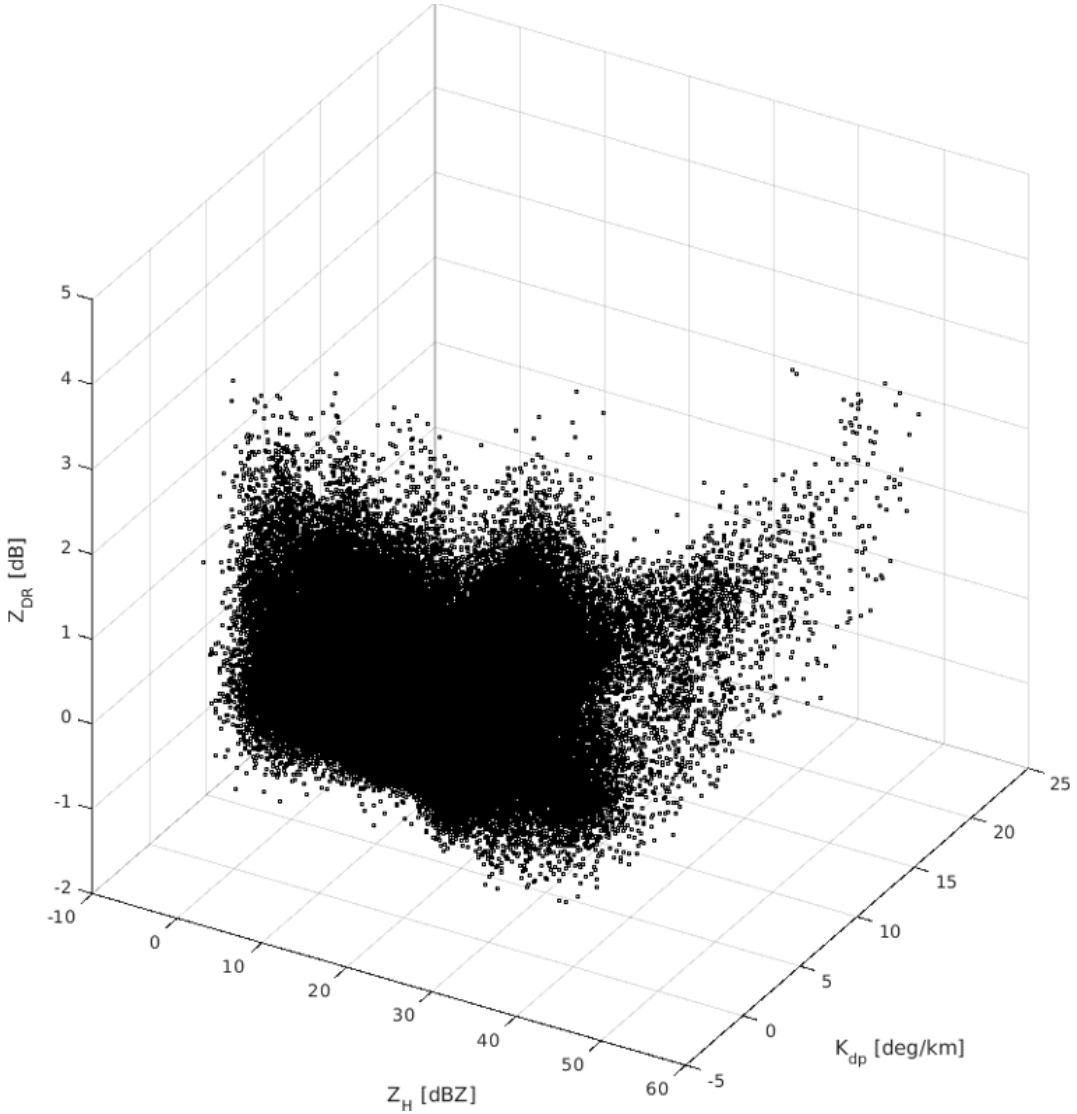
1. Hydrometeor classification: A novel approach
2. Hydrometeor classification: Hail detection
3. Conclusions and perspectives

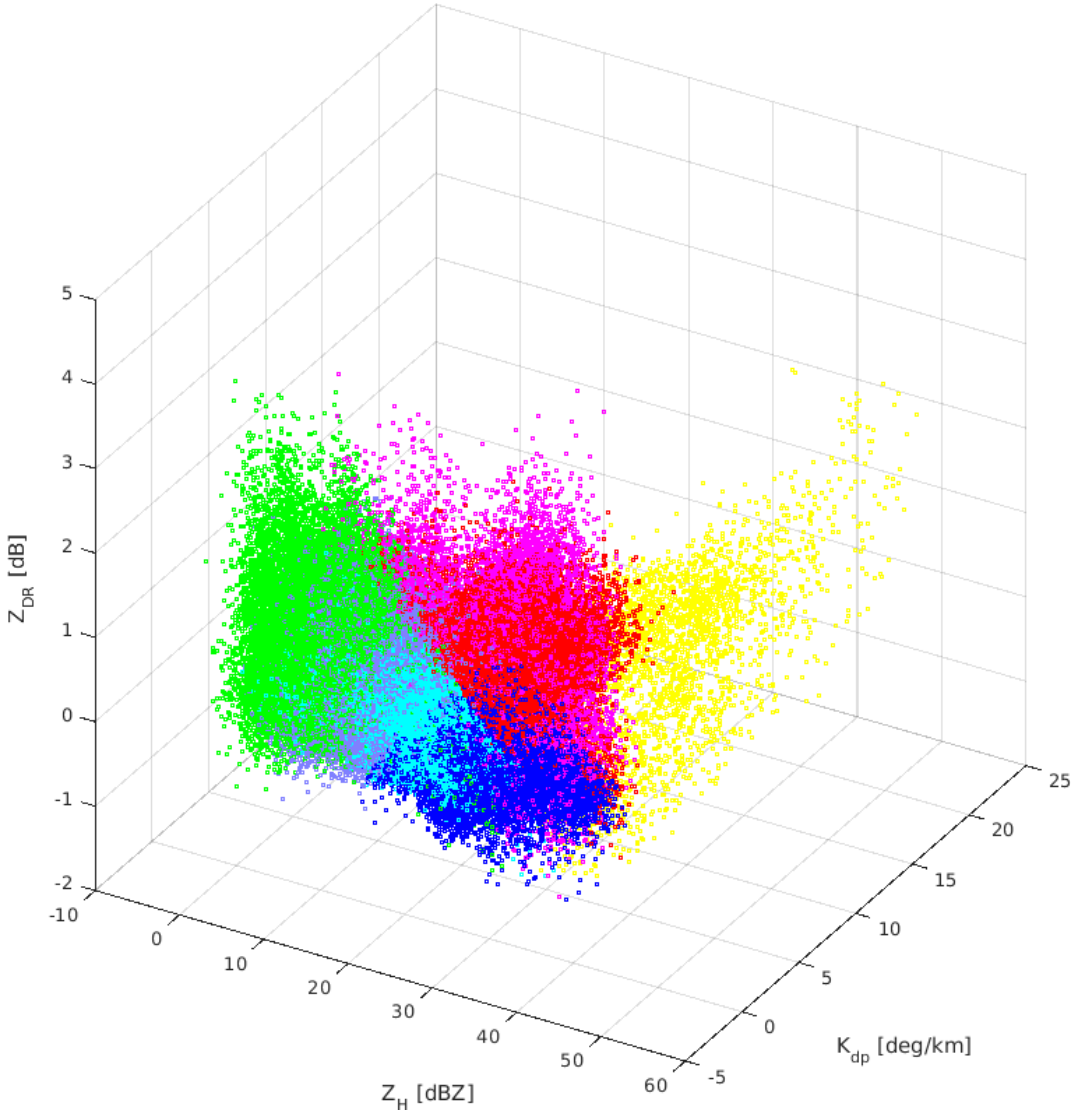
Hydrometeor classification: the problem



A number of radar observations, hopefully corresponding to precipitation...

- Z_H: concentration, size and density
- Z_{DR}: shape, orientation and density
- K_{dp}: concentration and shape
- ρ_{hv}: homogeneity
- + phase indicator: liquid/melting/solid

Hydrometeor classification: the solution



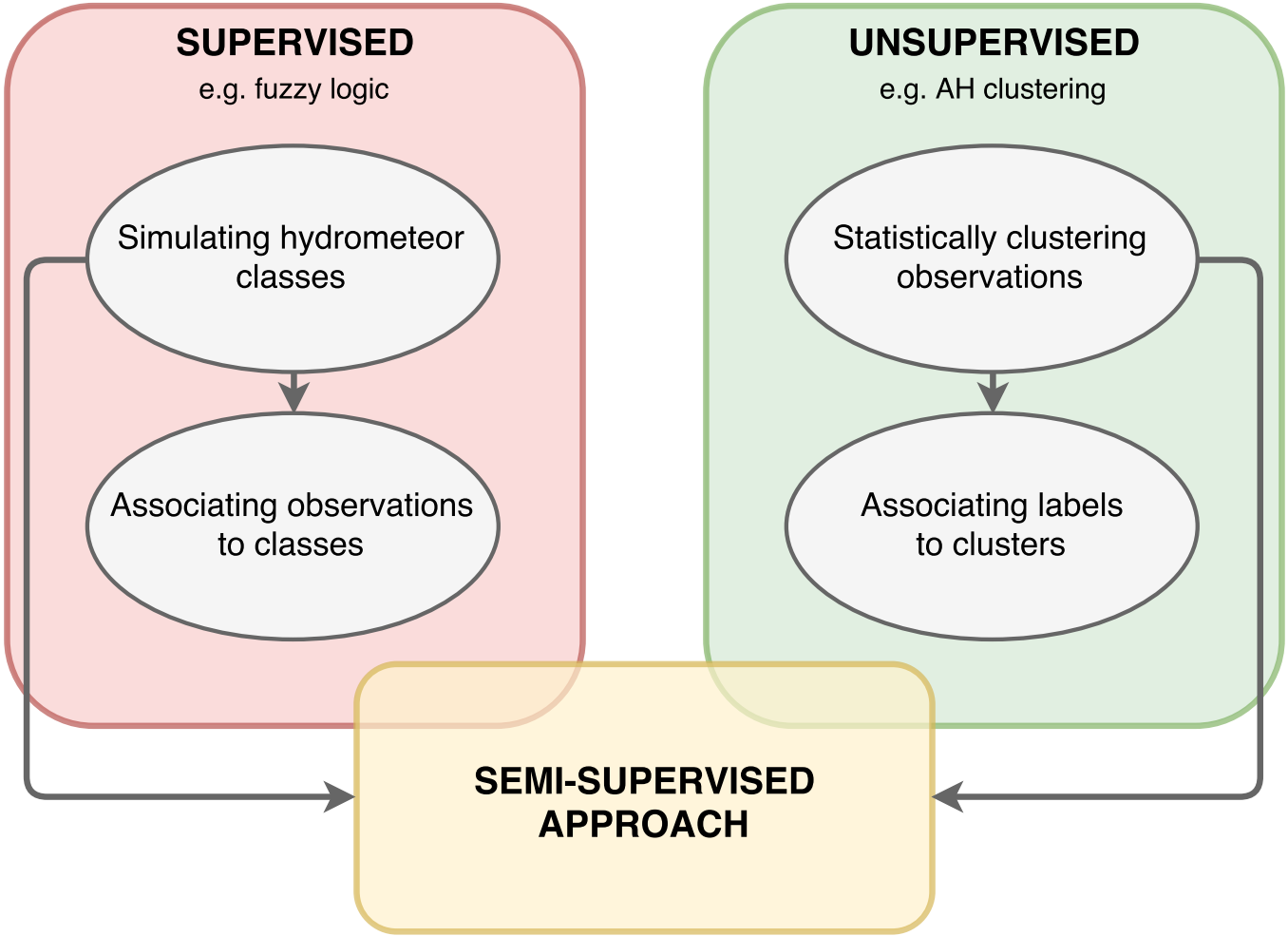
Proposing a method which can properly associate to each of these observations a label

-

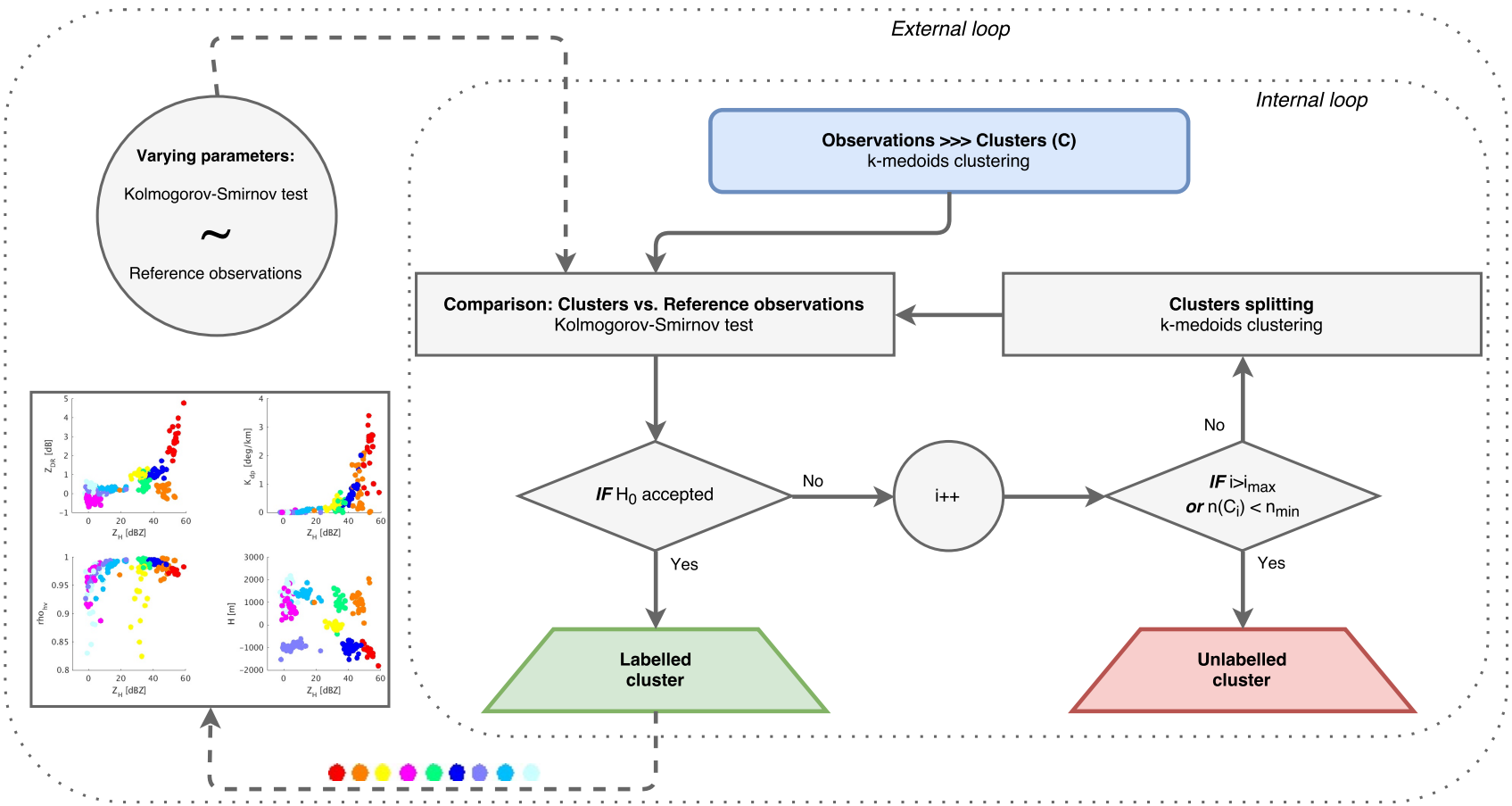
a hydrometeor type

- Z_H: concentration, size and density
- Z_{DR}: shape, orientation and density
- K_{dp}: concentration and shape
- ρ_{hv}: homogeneity
- + phase indicator: liquid/melting/solid

Schematic generalization of hydrometeor classification methods



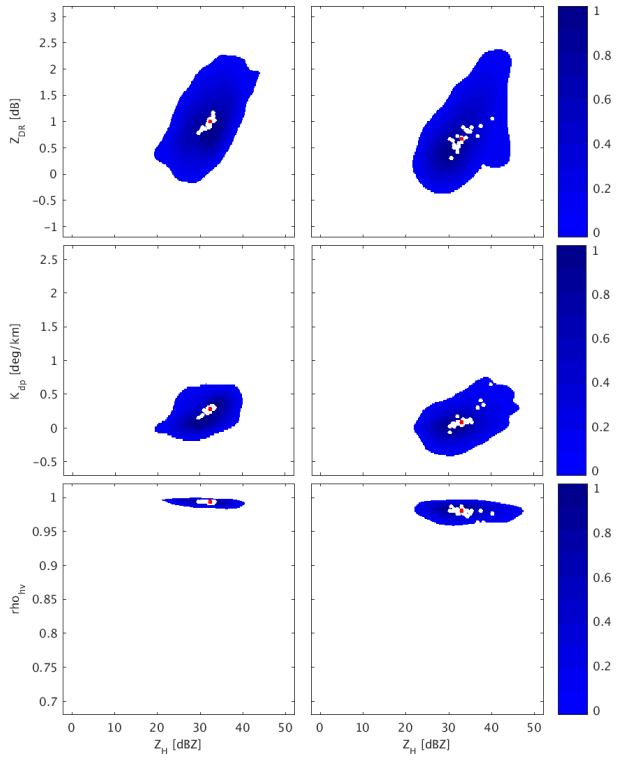
The schematic representation of the centroids derivation algorithm



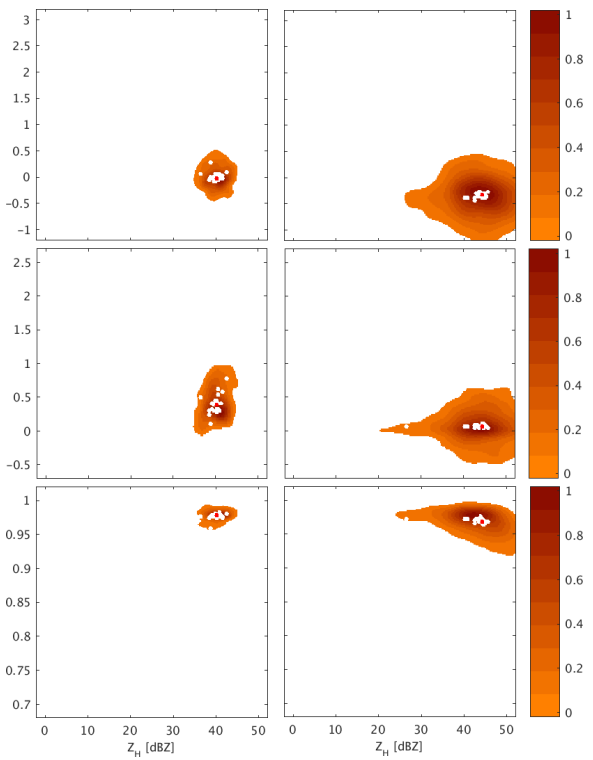
Besic, N., Figueras i Ventura, J., Grazioli, J., Gabella, M., Germann, U., and Berne, A.: Hydrometeor classification through statistical clustering of polarimetric radar measurements: a semi-supervised approach, Atmos. Meas. Tech., 9, 4425-4445, 2016.

Examples of PDFs estimated by means of Kernel Density Estimator (KDE) along with the centroids from all iterations, for MXPol (left) and DX50 (right) X-band datasets

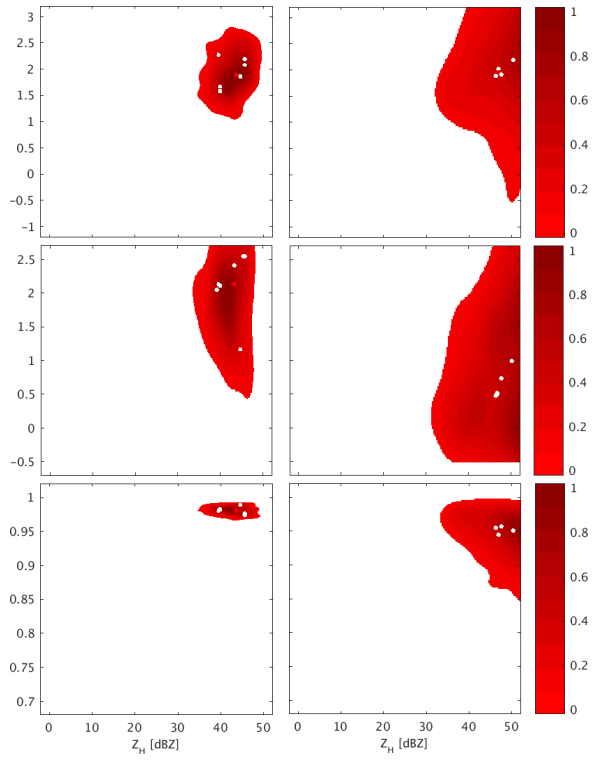
Rain



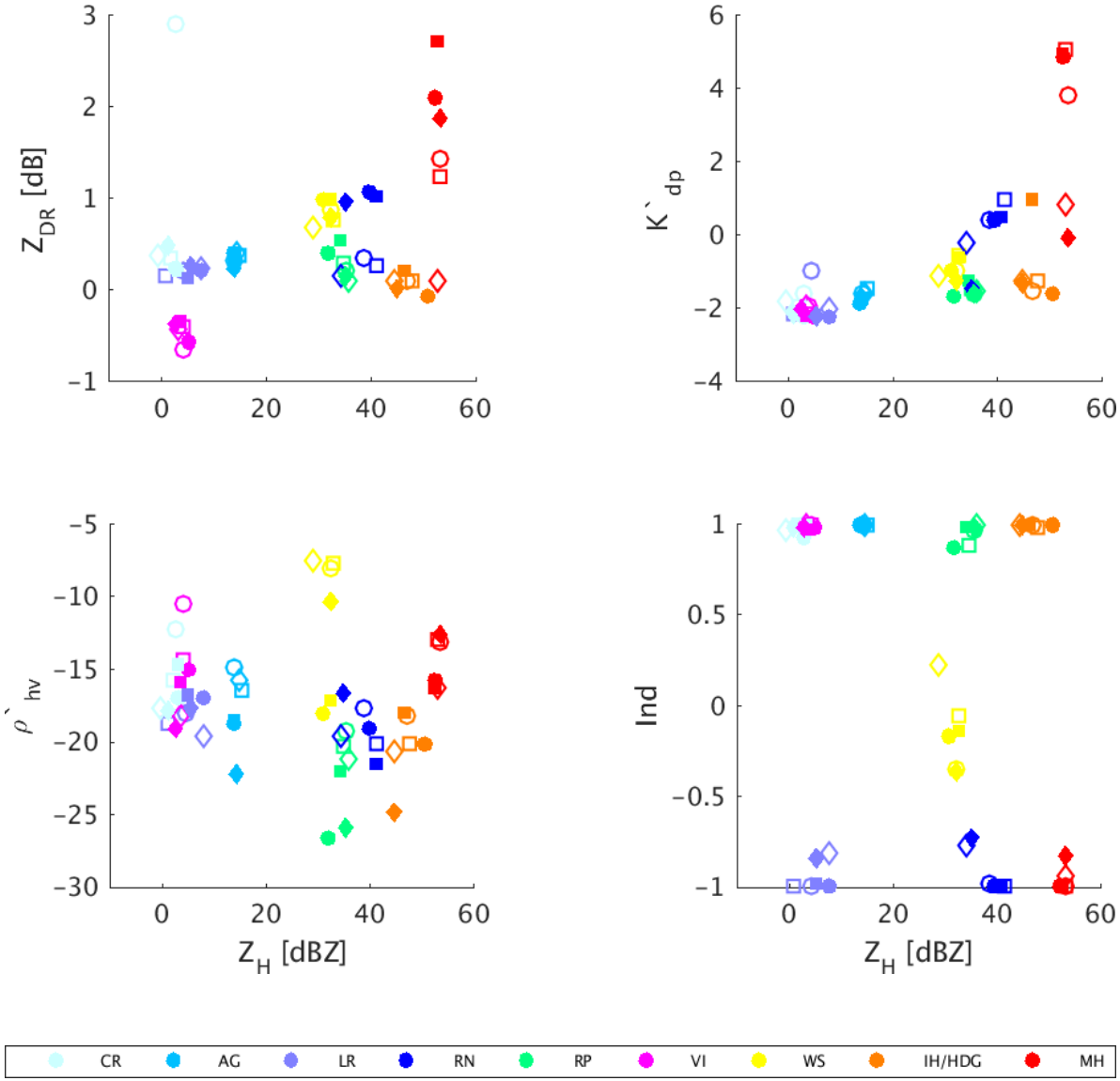
Ice hail/High density graupel



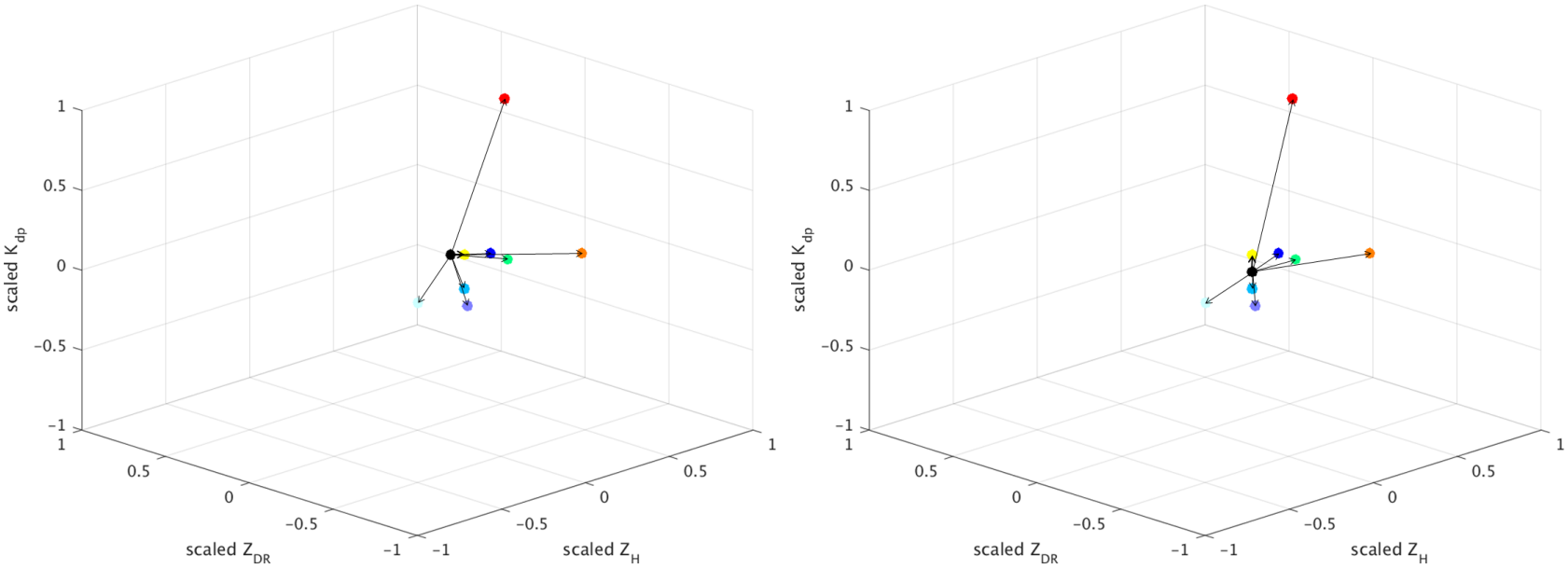
Melting hail



Centroids for Albis (○), Monte Lema (□) and Plaine Morte (◊) radars: before (empty) and after (filled) attenuation and noise corrections



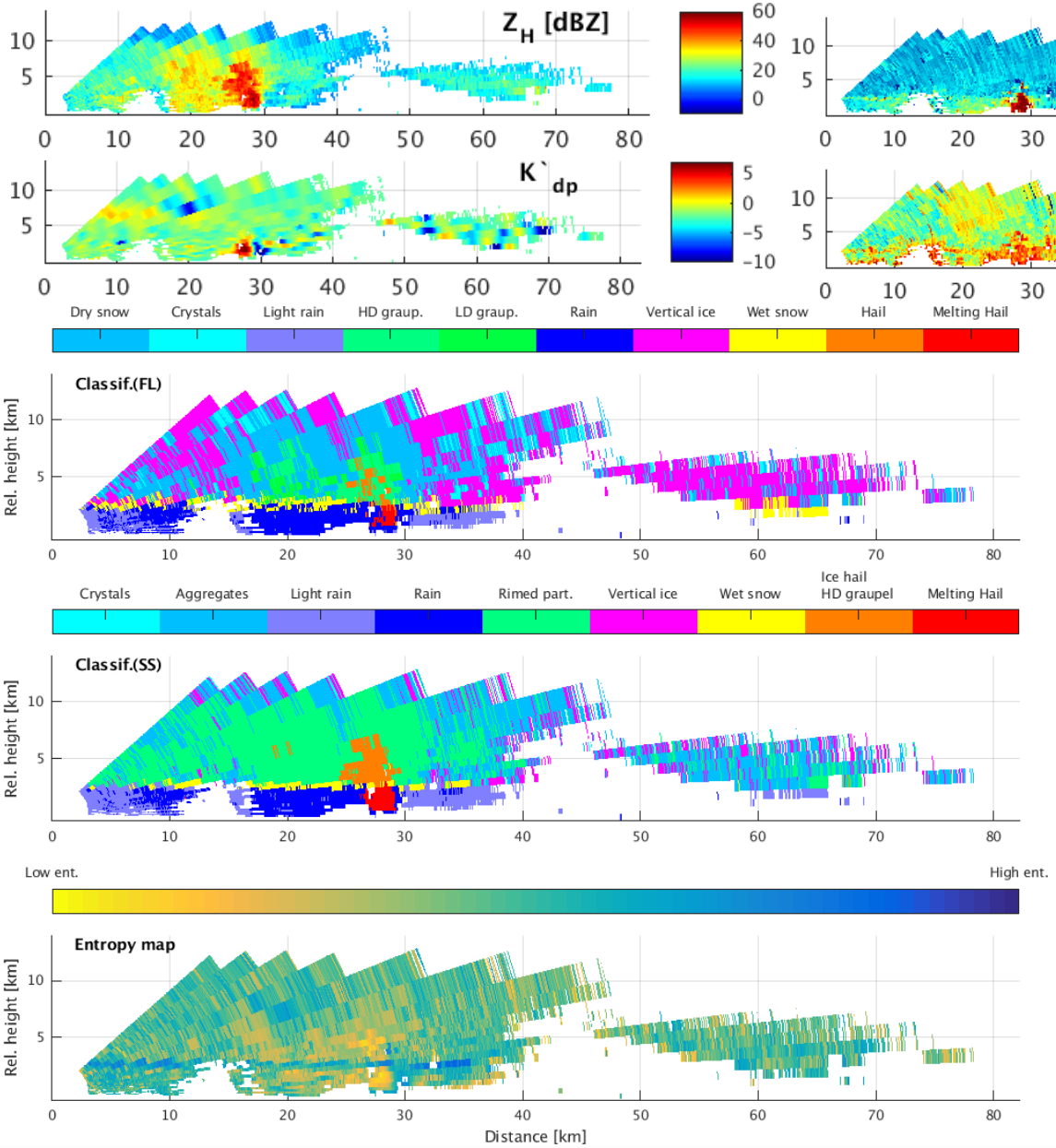
Pixel assignment
&
Min-entropy as a measure on uncertainty

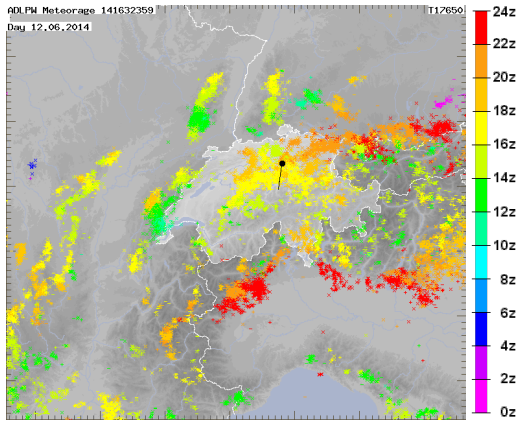


Example of pixel assignment:

- (left) lower entropy: 0.2753
- (right) higher entropy: 0.4756

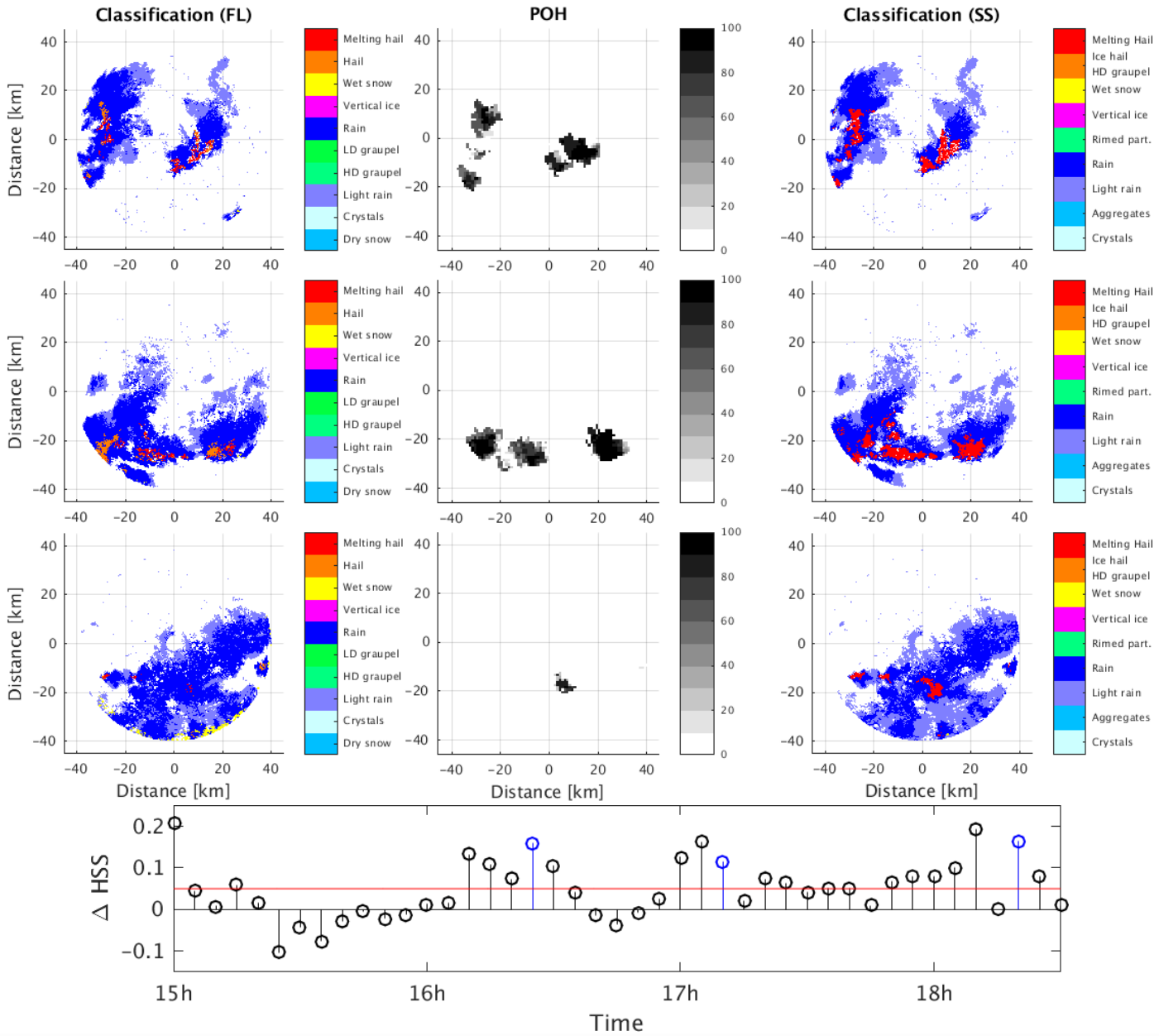
C-band Albis reconstructed RHI profile, 187° azimuth, 17h30, 12/06/14





Lightning daily distribution

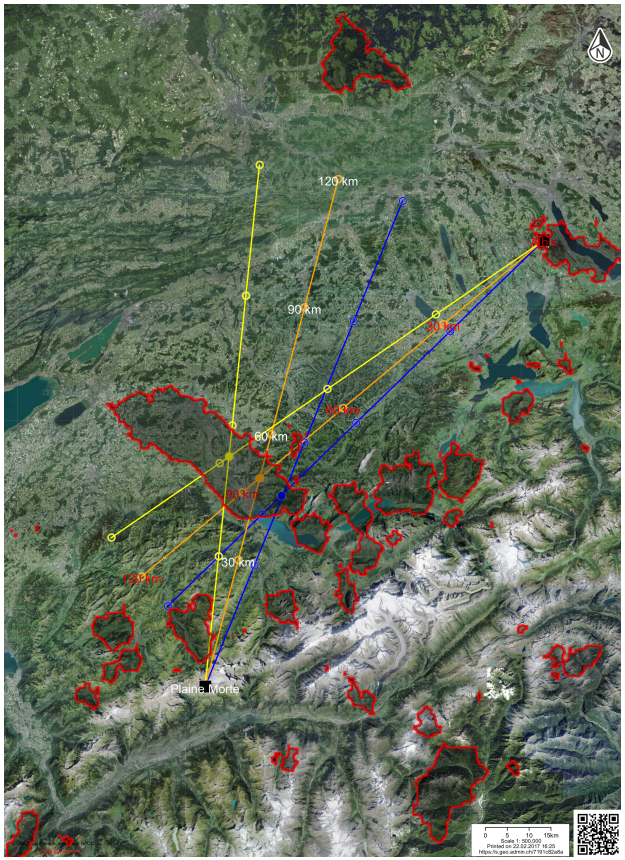
C-band Albis radar, PPI 2.5° elevation, 12/06/14

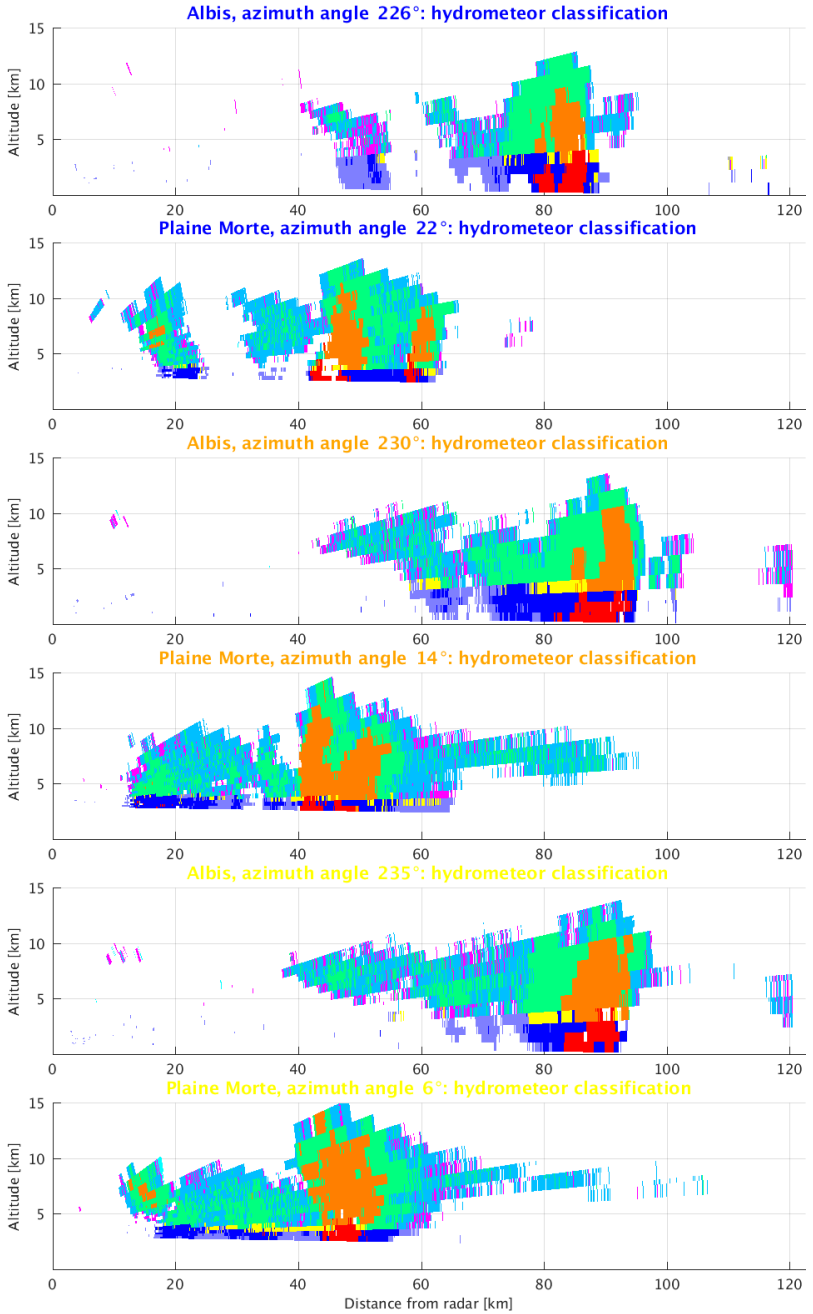


Thun case study

6 June 2015

15h55, 16h40 and 16h55

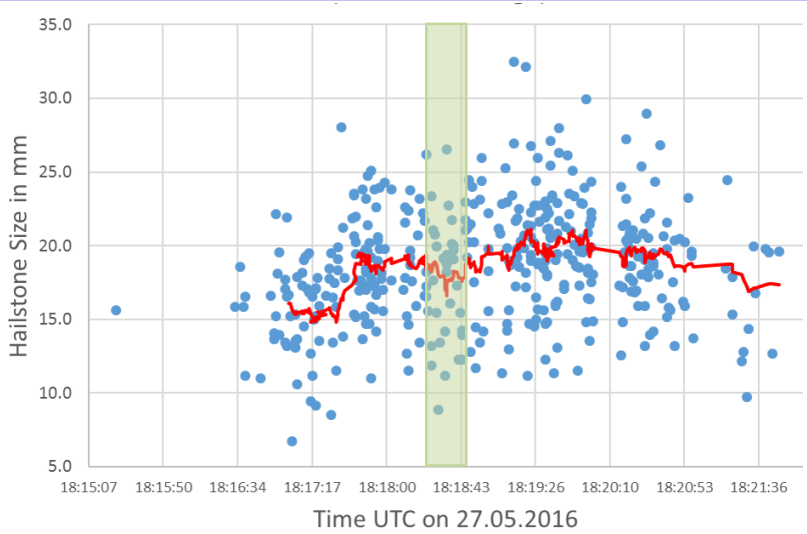




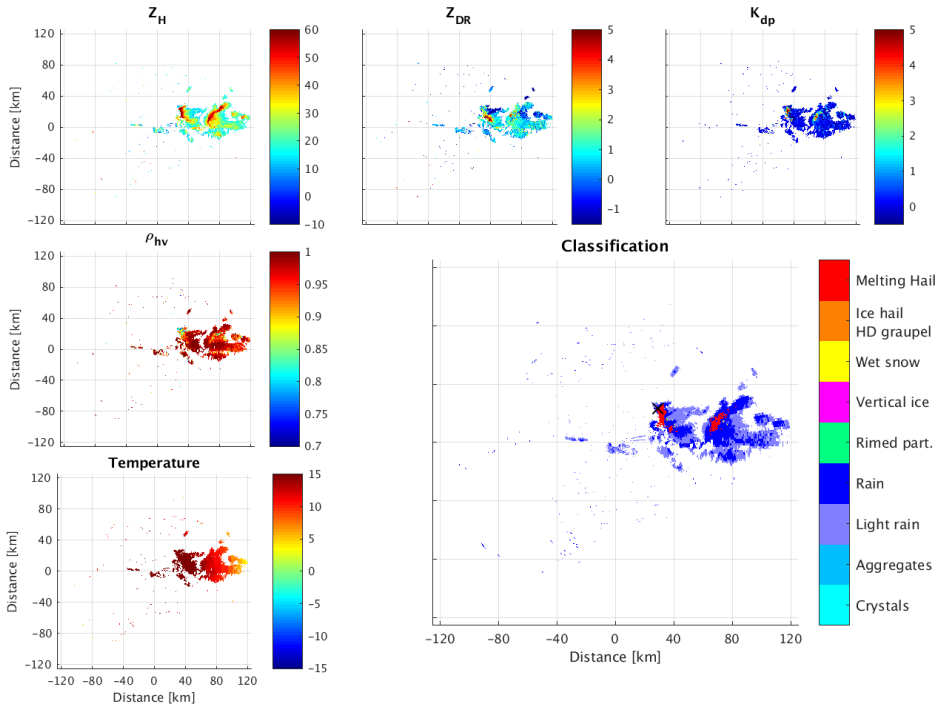
Thurgau case study

27 May 2016

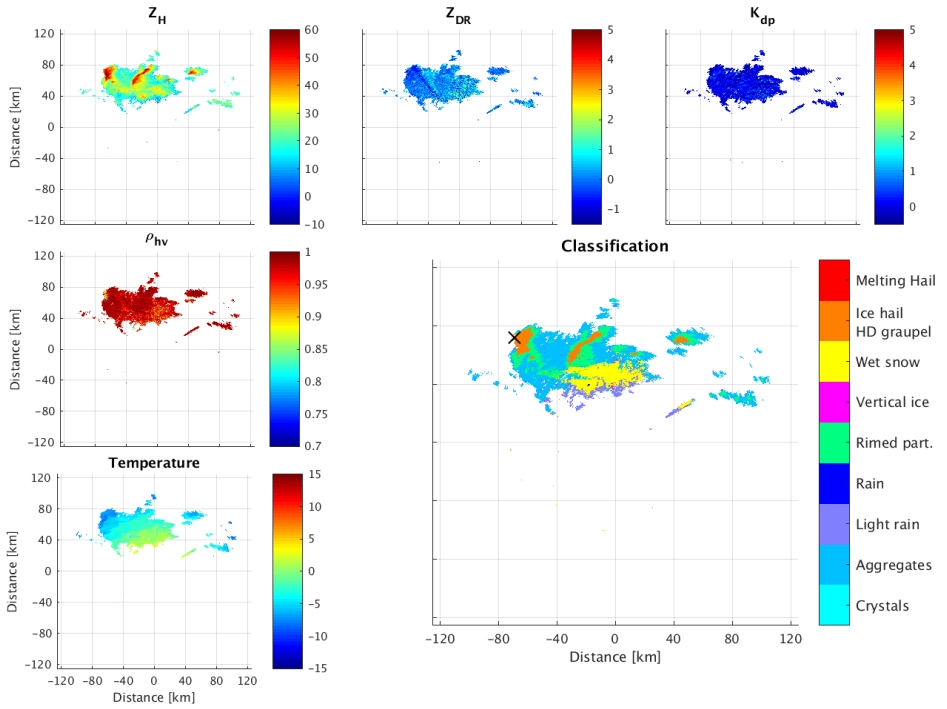
Hailstone sensor in Aadorf ($\times$)



Albis, PPI ($\theta = 0.4°$), 18h18m25-18h18m45



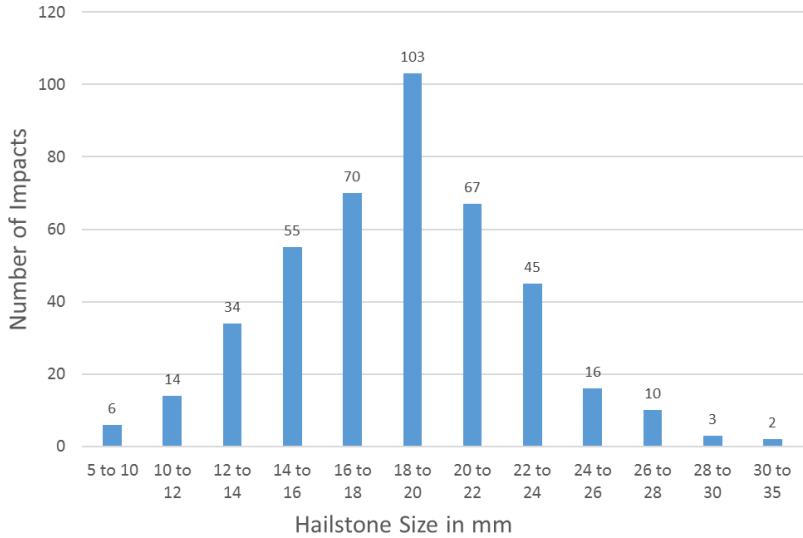
Weissfluhgipfel, PPI ($\theta = 0.4°$), 18h18m25-18h18m45



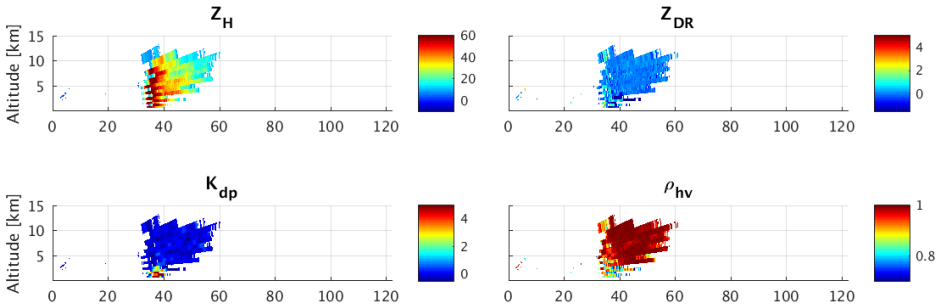
Thurgau case study

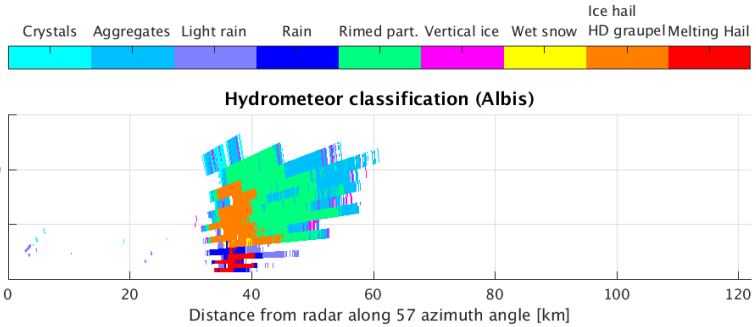
27 May 2016

Hailstone sensor in Aadorf

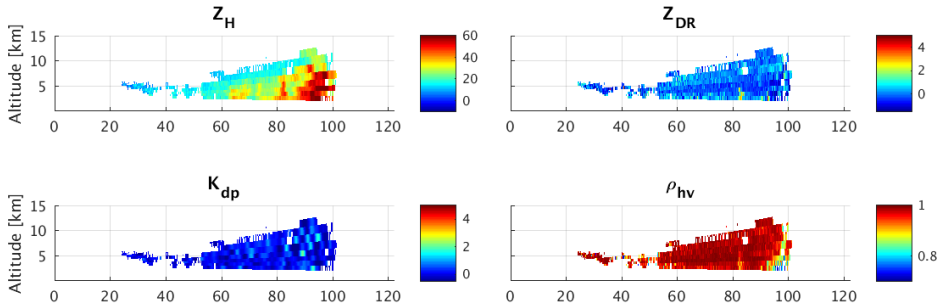


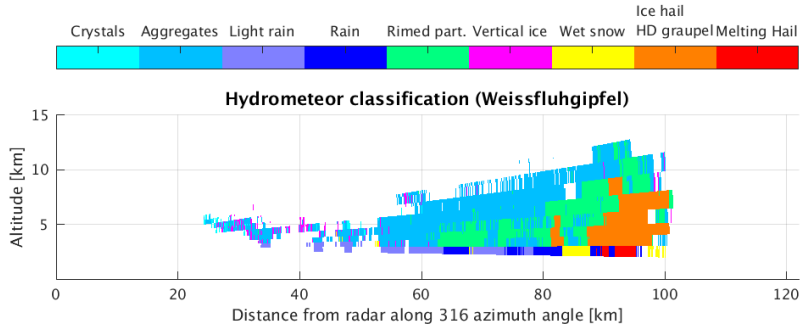
Albis, RHI ($\phi = 57°$), 18h15-18h20





Weissfluhgipfel, RHI ($\phi = 316°$), 18h15-18h20



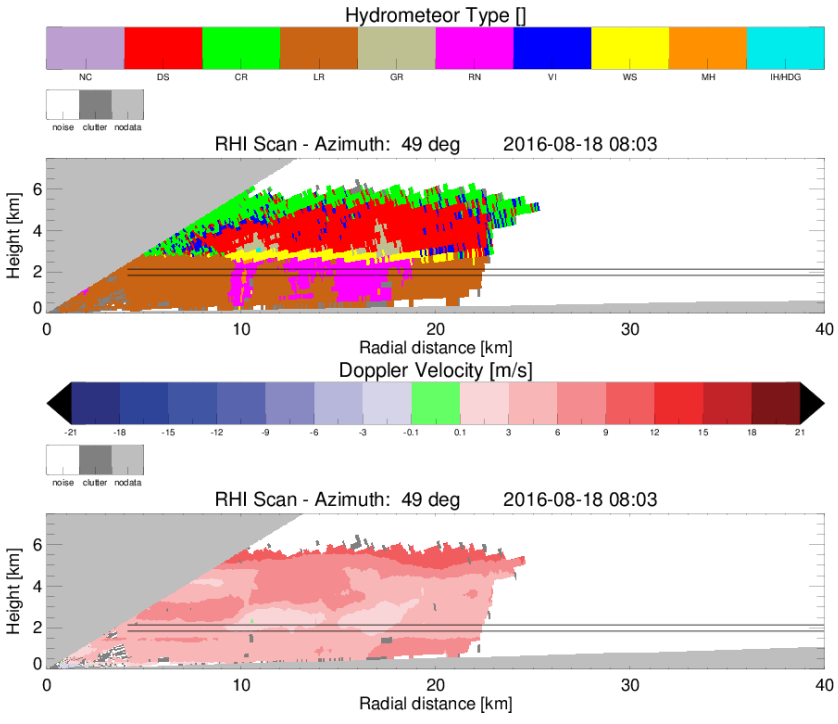
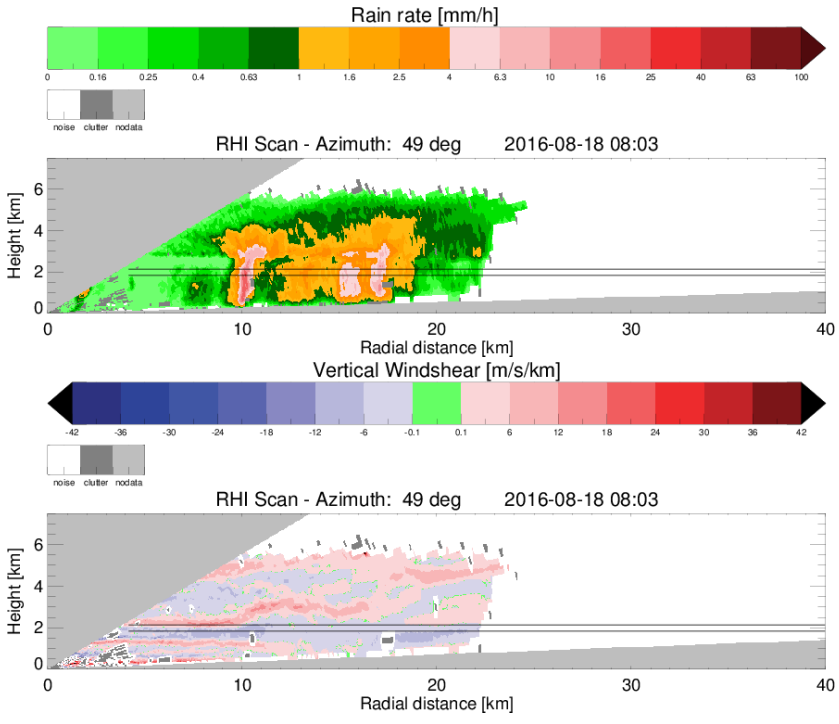


Conclusions and perspectives

Conclusions

- volumetric observation of hail cells
- improved hail detection with respect to the classical HC
- compliance with the POH and hail-sensors

Perspectives

- hail sub-classification relative to the size of hailstones
- volumetric radar composite
- database of hail events

Danke! Merci ! Grazie! Grazia!