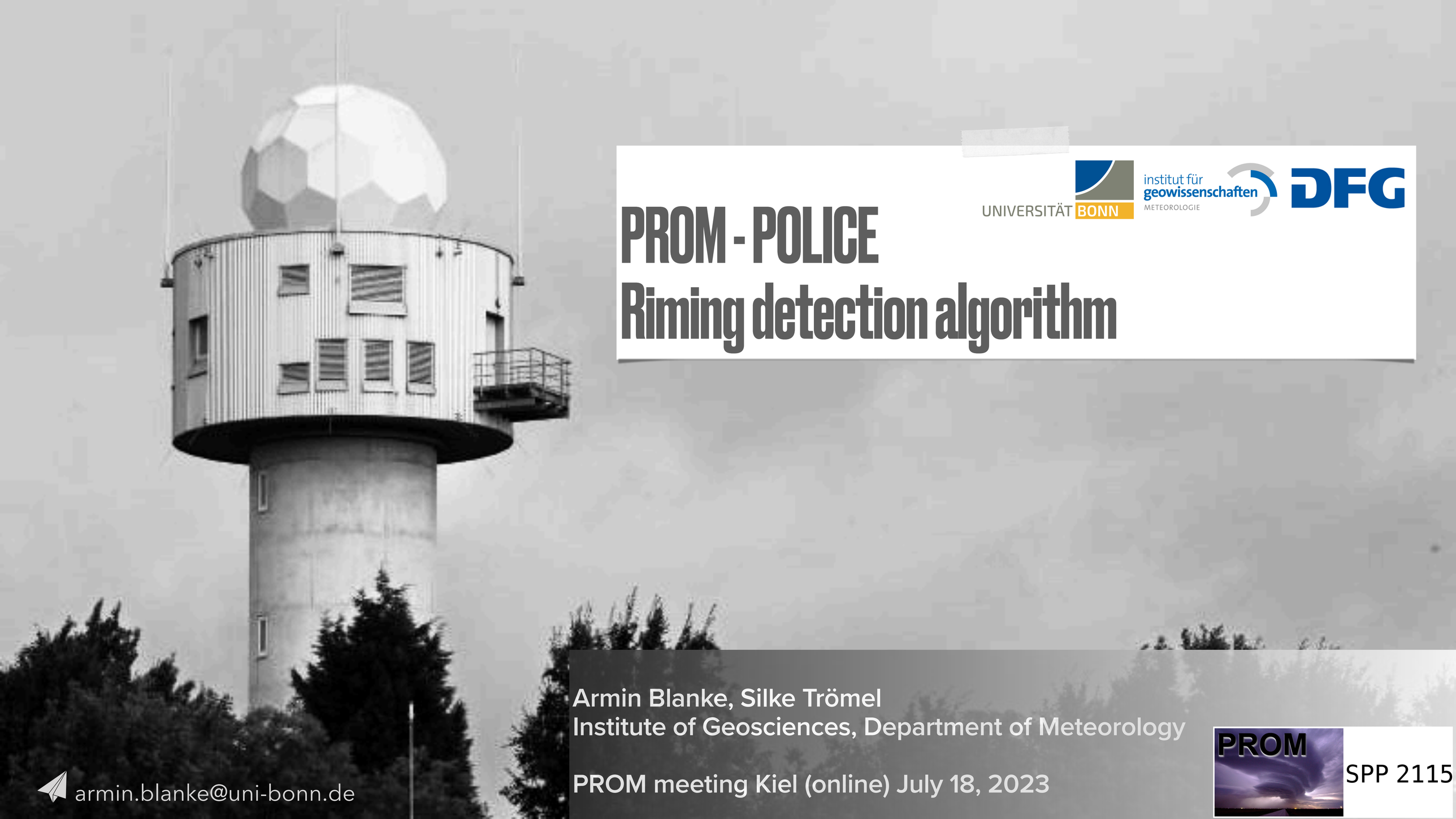

PROM - POLICE
Riming detection algorithm

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PROM meeting Kiel (online) July 18, 2023

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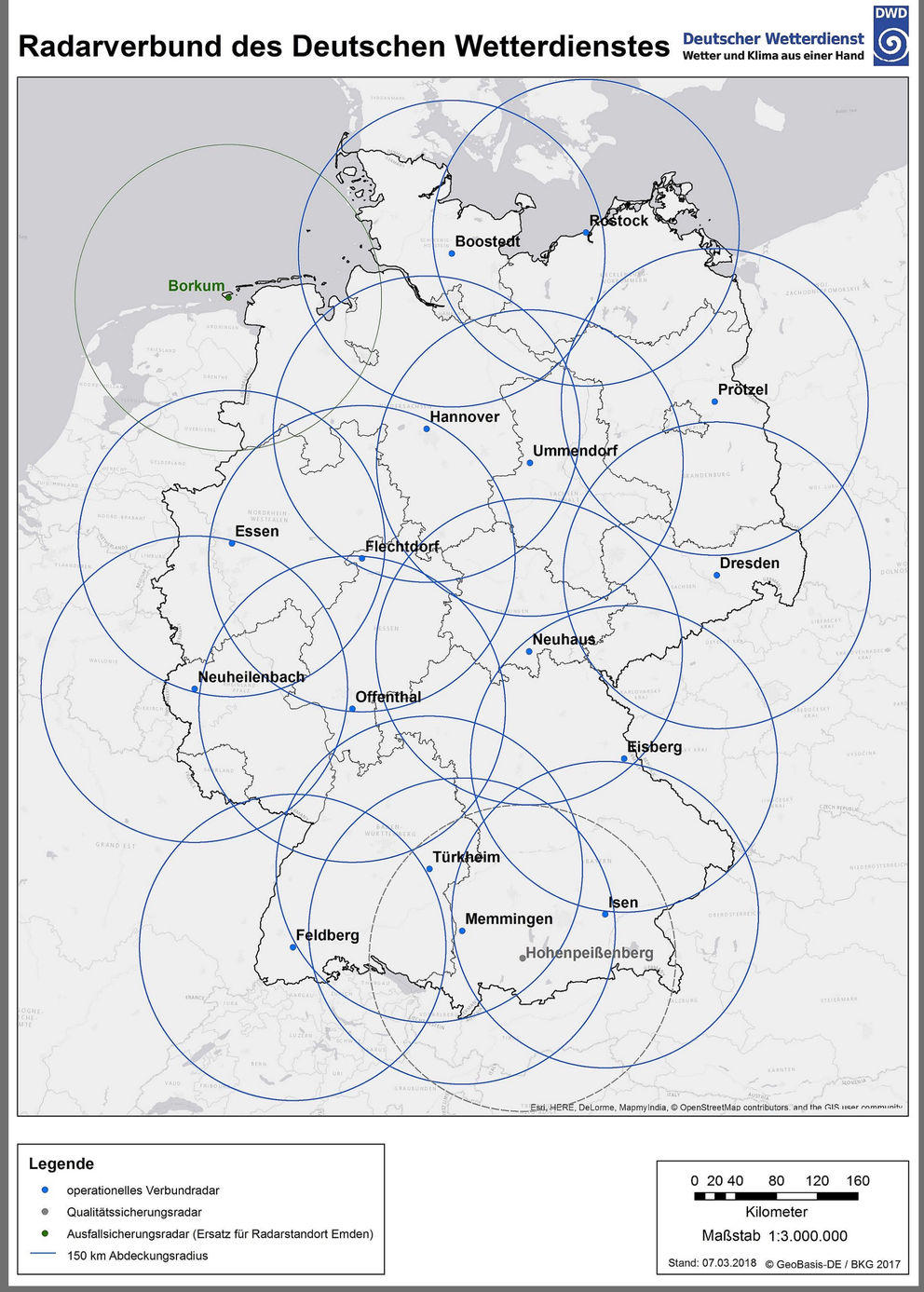
SPP 2115

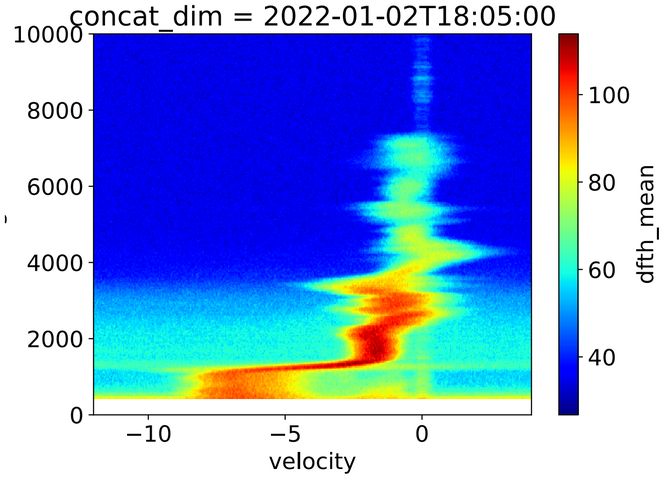
Goal: Radar algorithm to discriminate between aggregation and riming

- Data: C-band radar data
- Selected riming cases from DWD‘s Essen (ESS) radar
- Make use of promising depolarization ratio (DR) and check with Doppler spectra fall velocities
- Doppler spectra from birdbath scans of all 17 operational DWD radars since 18.05.2021
- New method: Isolated Doppler spectra (Gergely et al. 2022) displayed as VP in time vs. height format
- VPs: fall velocity, signal power, rime mass fraction (RMF, Kneifel and Moisseev 2020)



Doppler spectra vertical profiles

1



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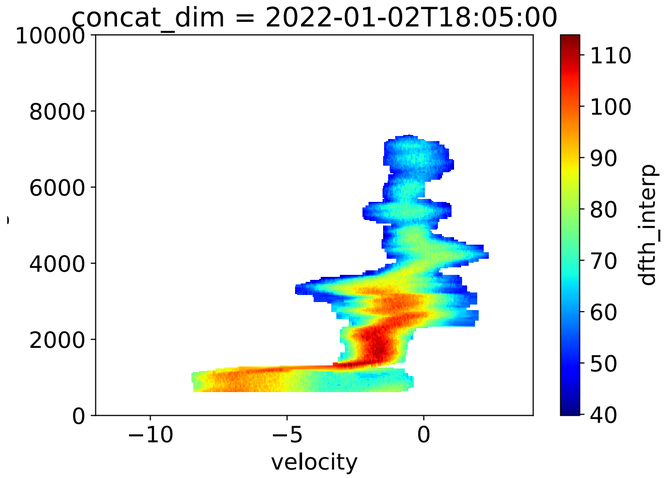
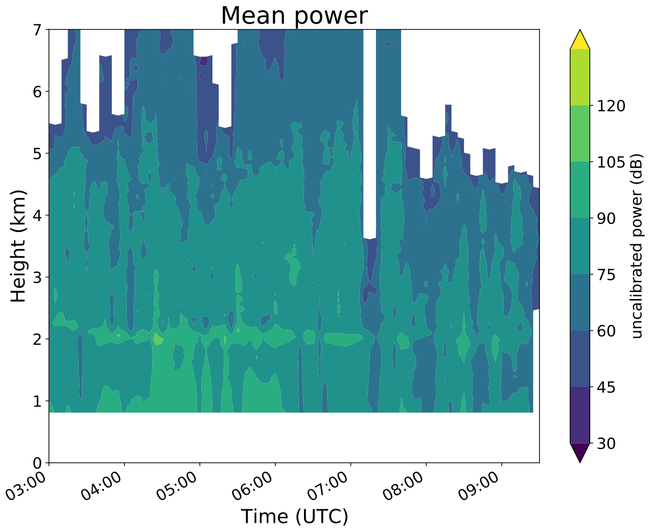
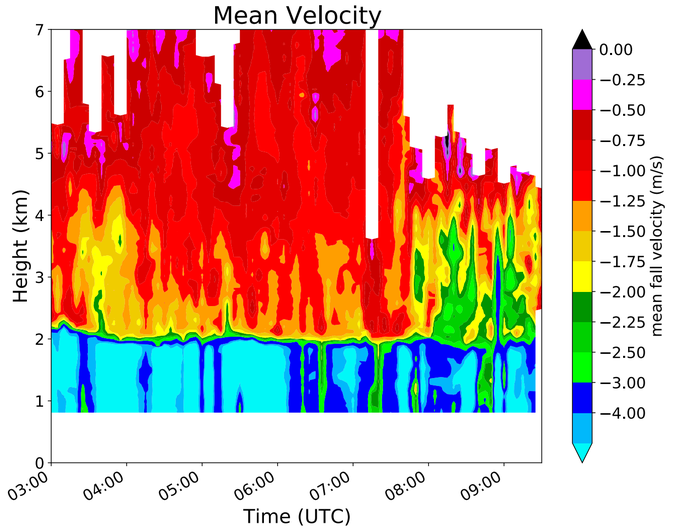


following
Gergely et al. (2022)

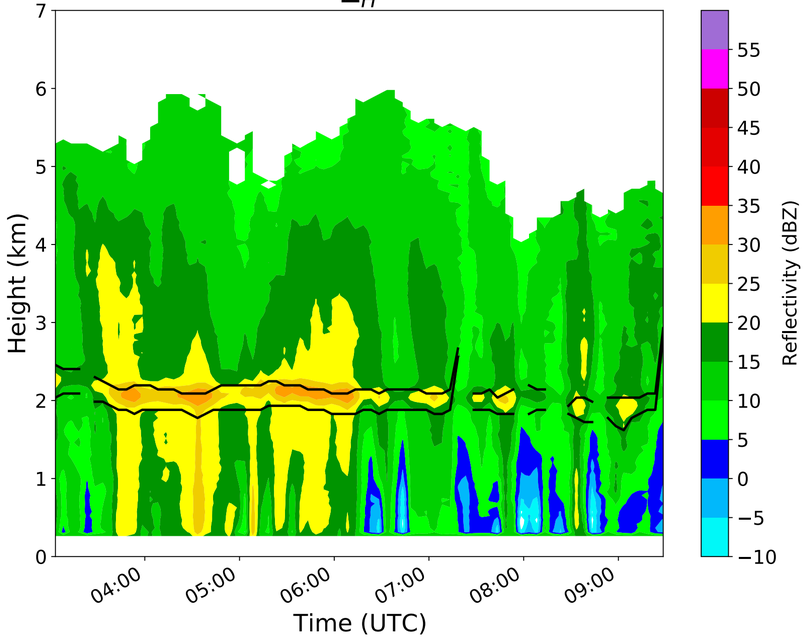
3

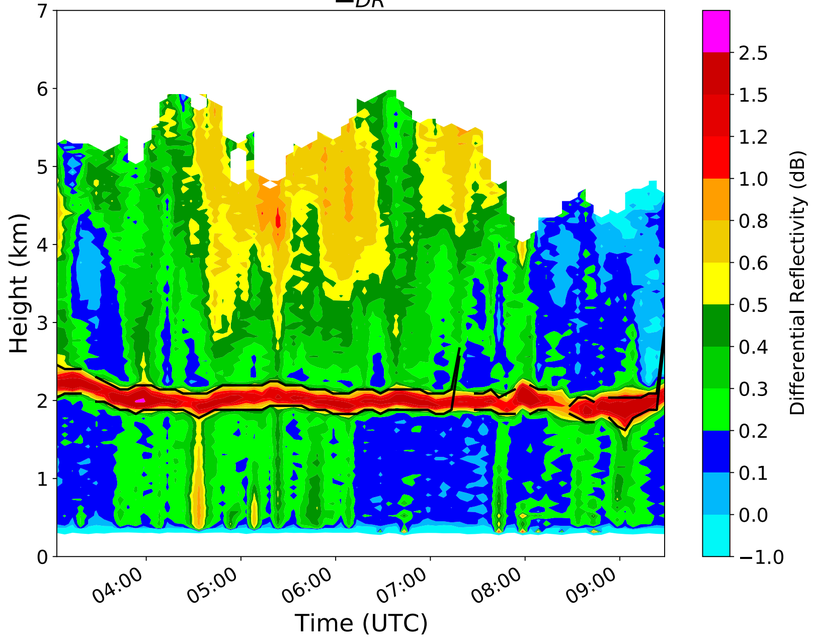


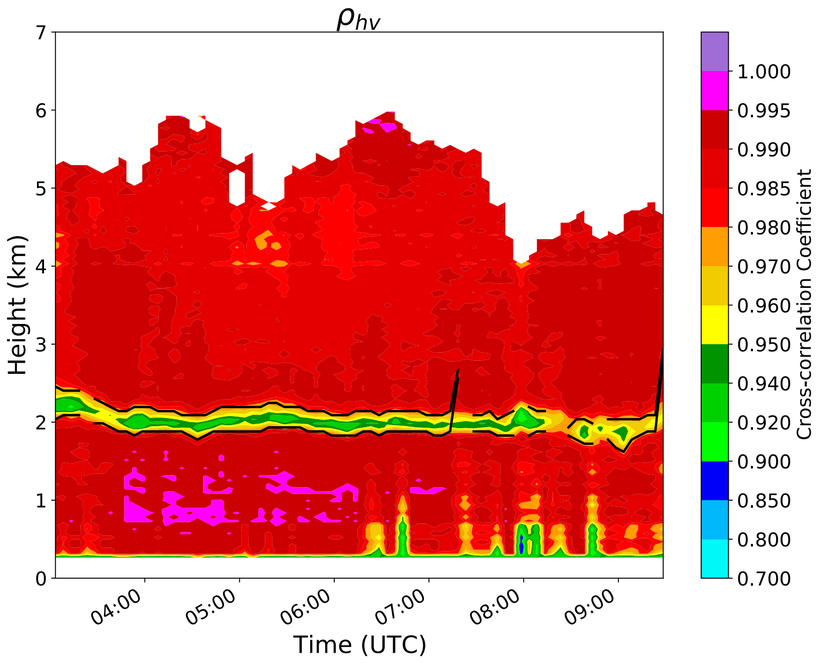


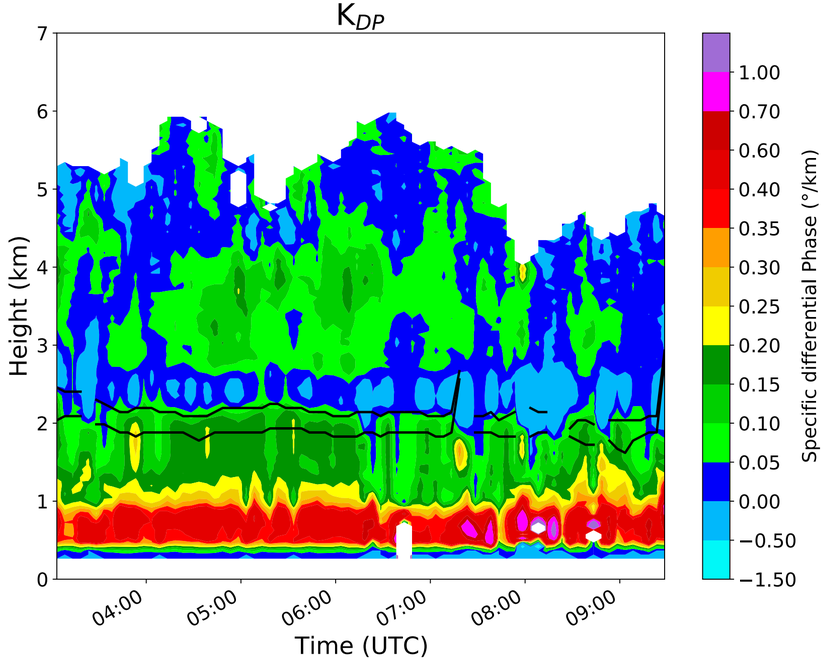
C-band QVPs

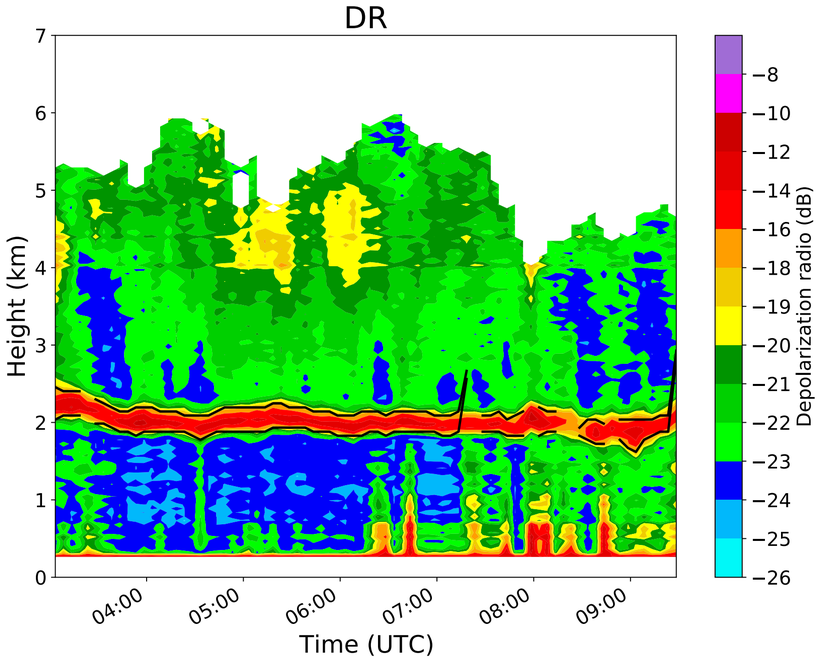
- 02.01.2022 | ESS
- Elevation angle 12°
- Valid values ≥ 60
- $SNRH > 10$
- $\rho_{HV} \geq 0.8$
- Restricted to max. range 35 km





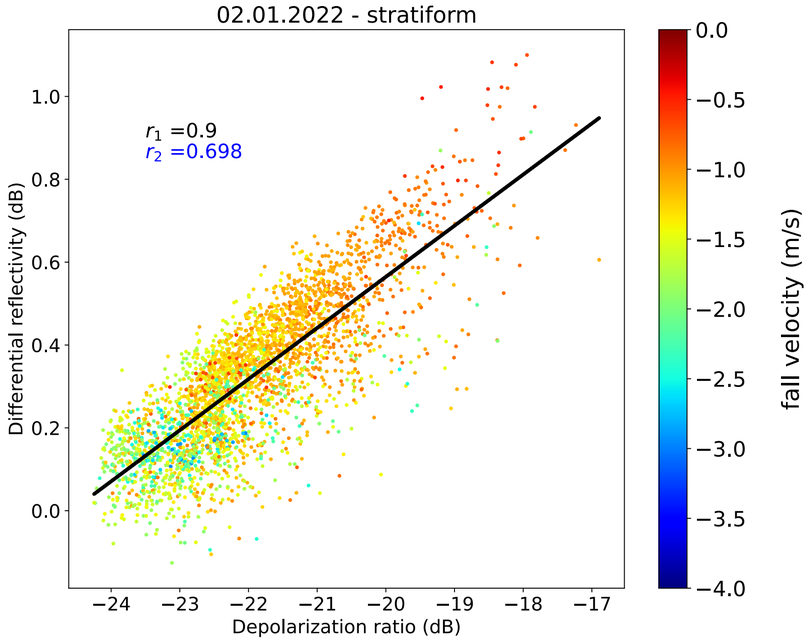


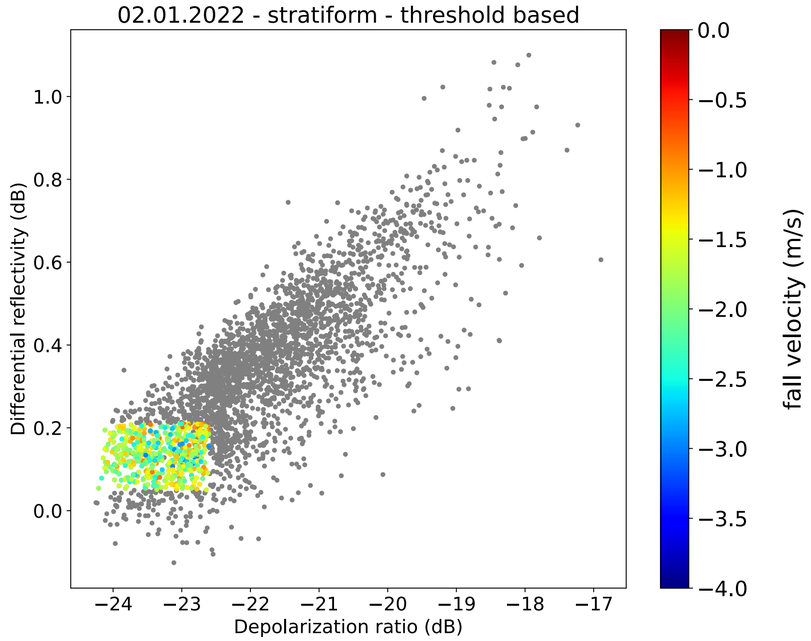




How do we find riming periods?

Via threshold based detection routine





r_1: DR vs. Z_{DR}

r_2: DR vs. fall velocity

Mean fall velocity = -1.06 m/s

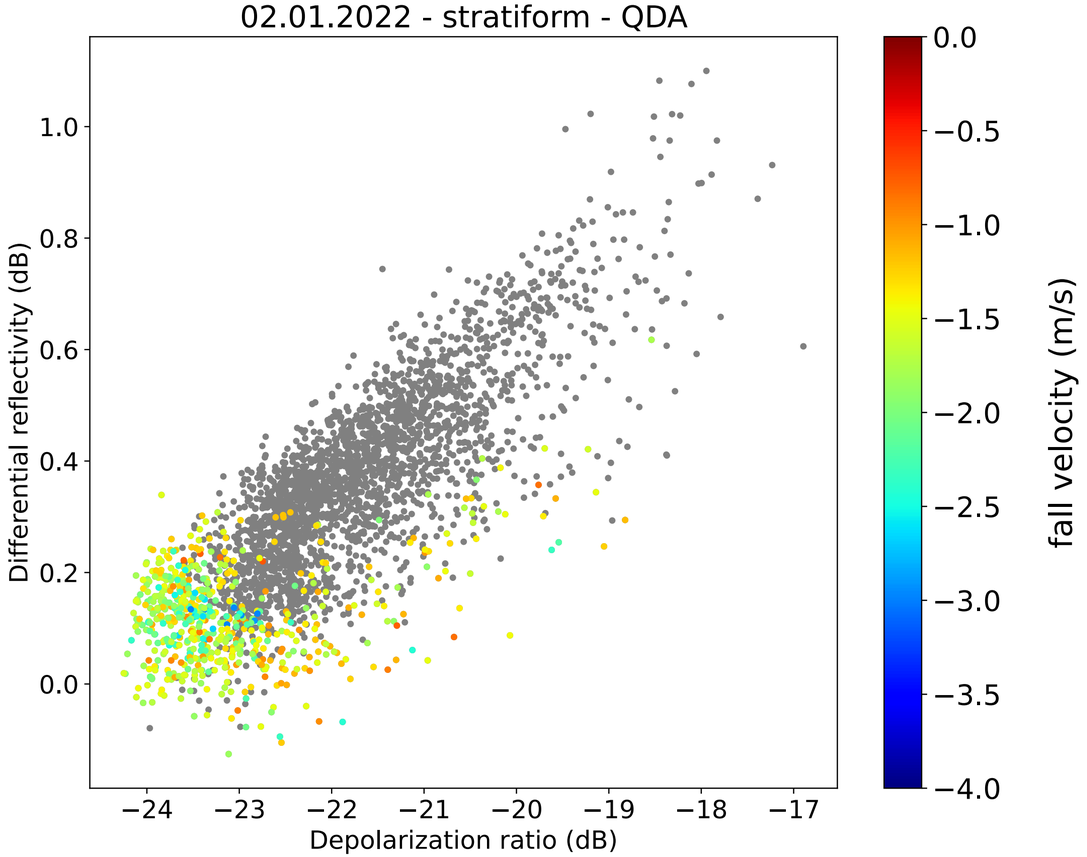
0.05 dB < Z_{DR} < 0.21 dB,

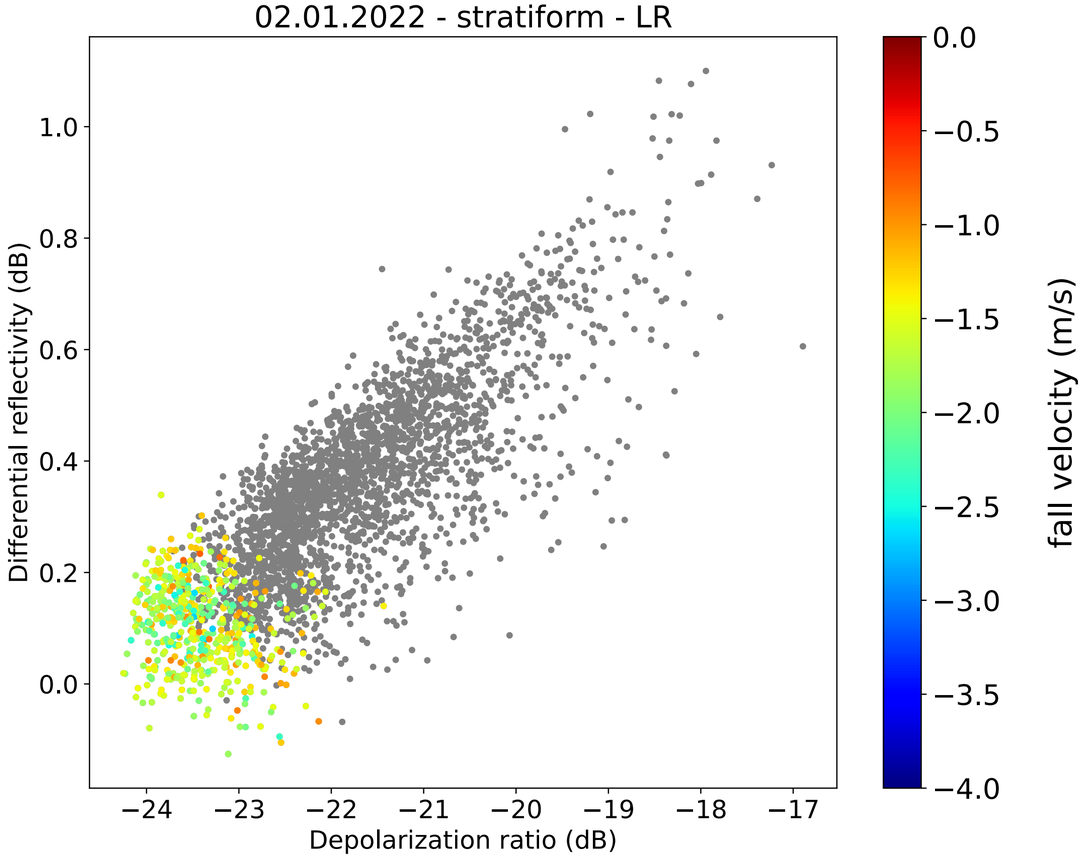
Z_H > 10 dBZ, DR <= -22.6 dB

Mean fall velocity = -1.63 m/s

How do we find riming periods?

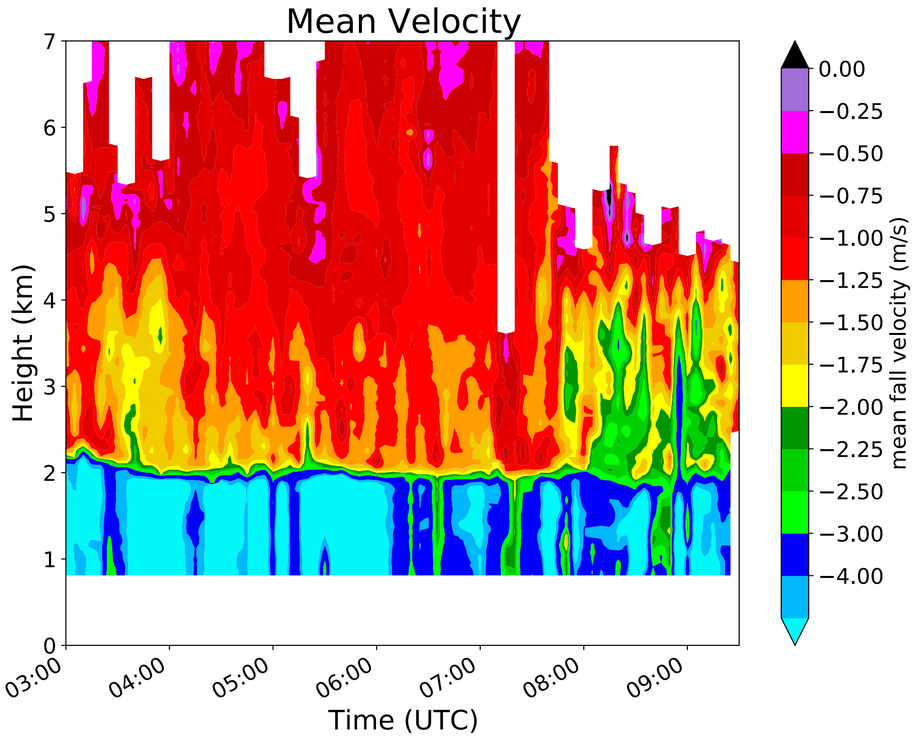
Via quadratic discriminant analysis (QDA) / logistic regression (LR)

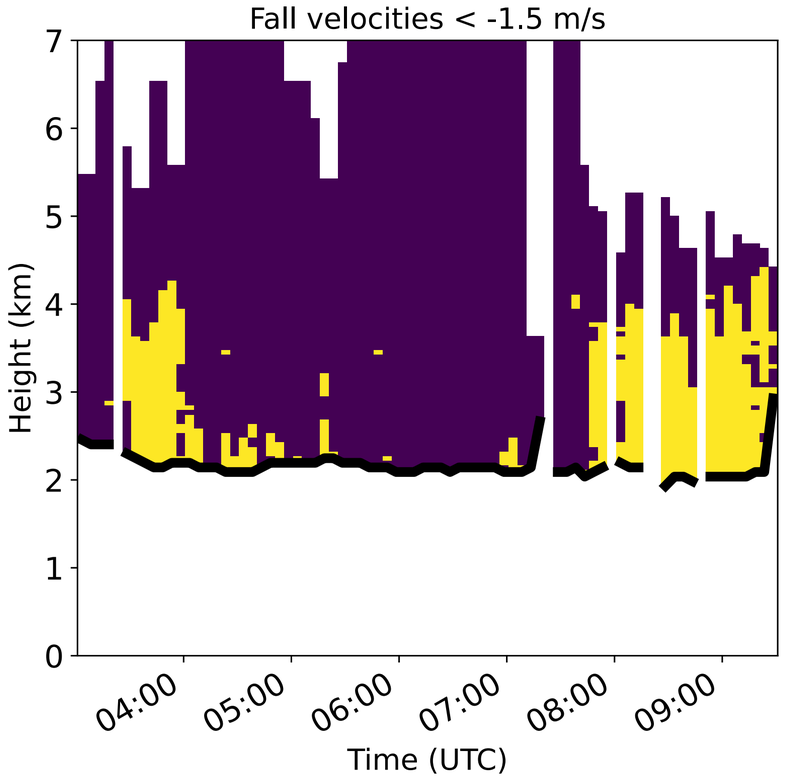


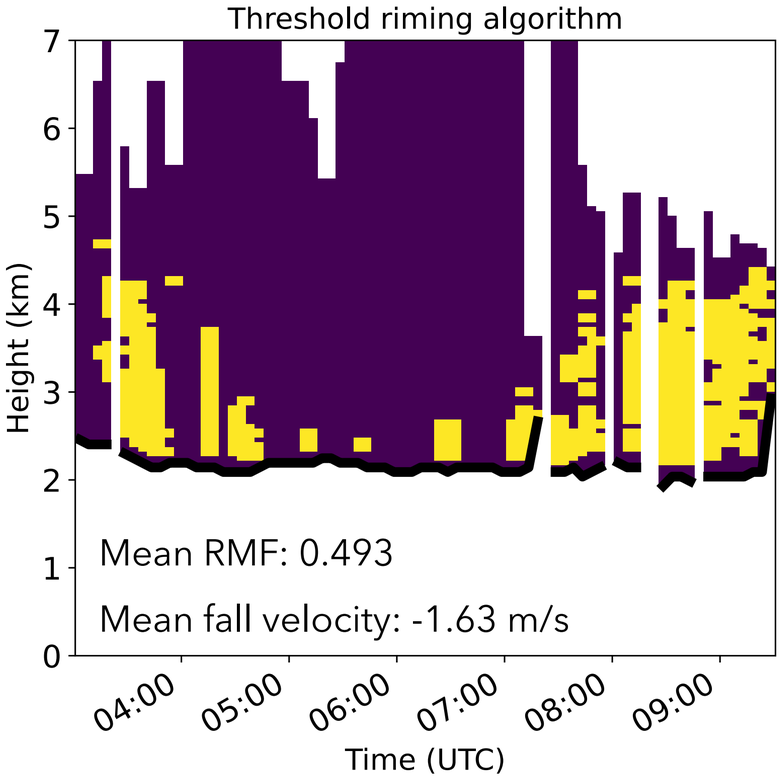


Binary classification test

Via threshold based algorithm



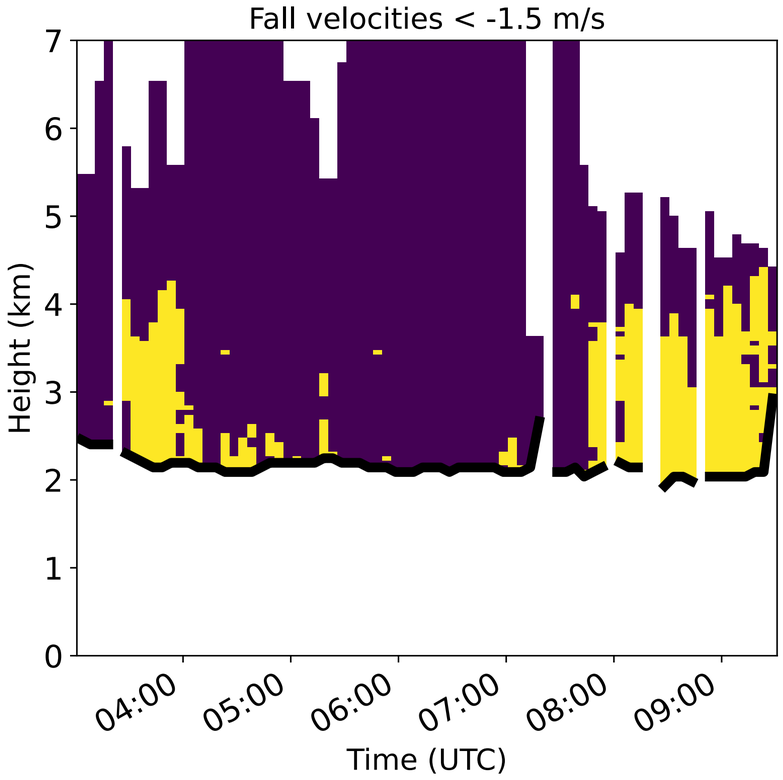


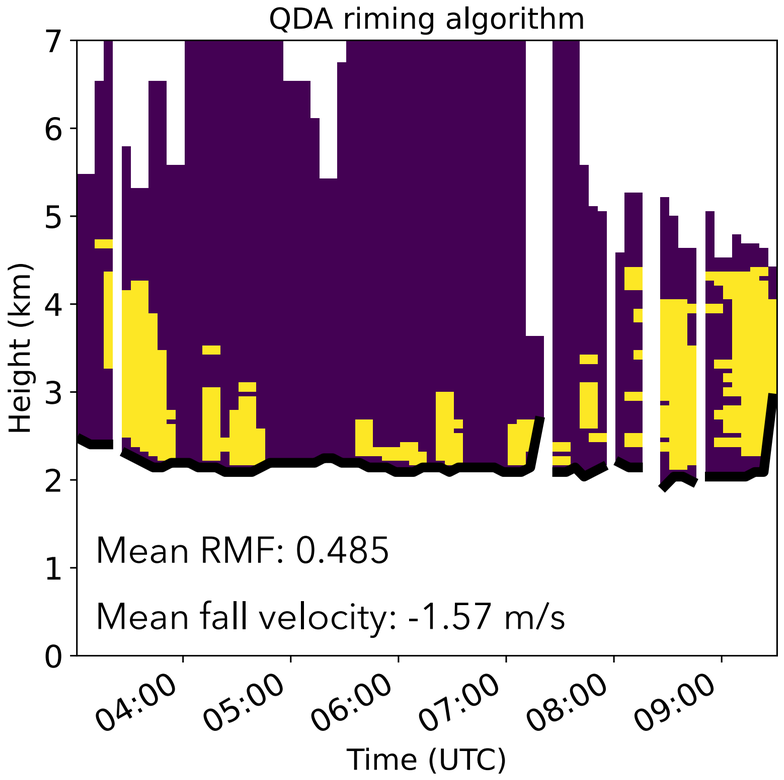


Jaccard coefficient: 0.426

F1 score: 0.6, accuracy: 0.88

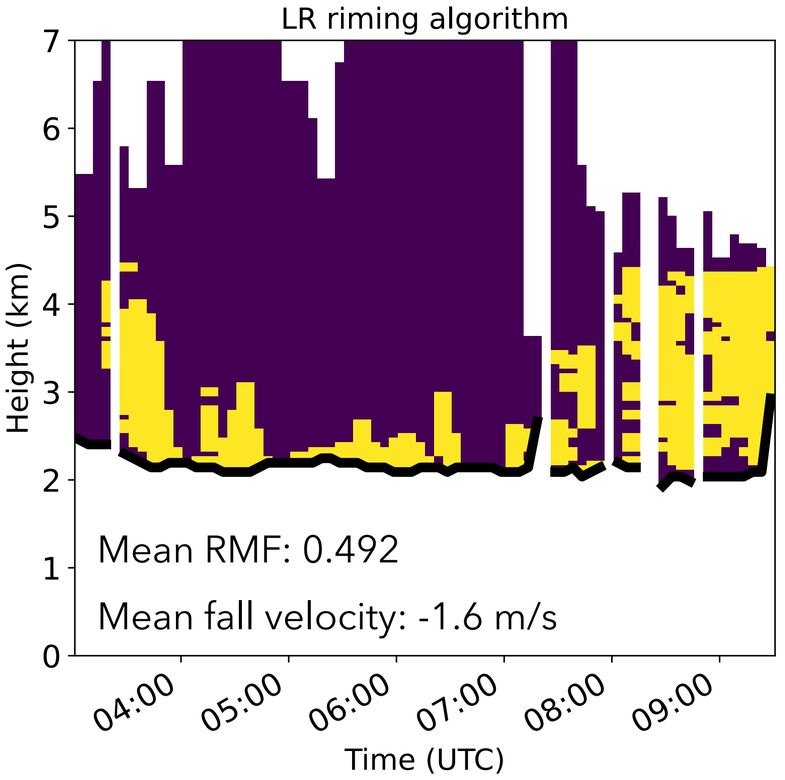
QDA and LR





Jaccard coefficient: 0.38

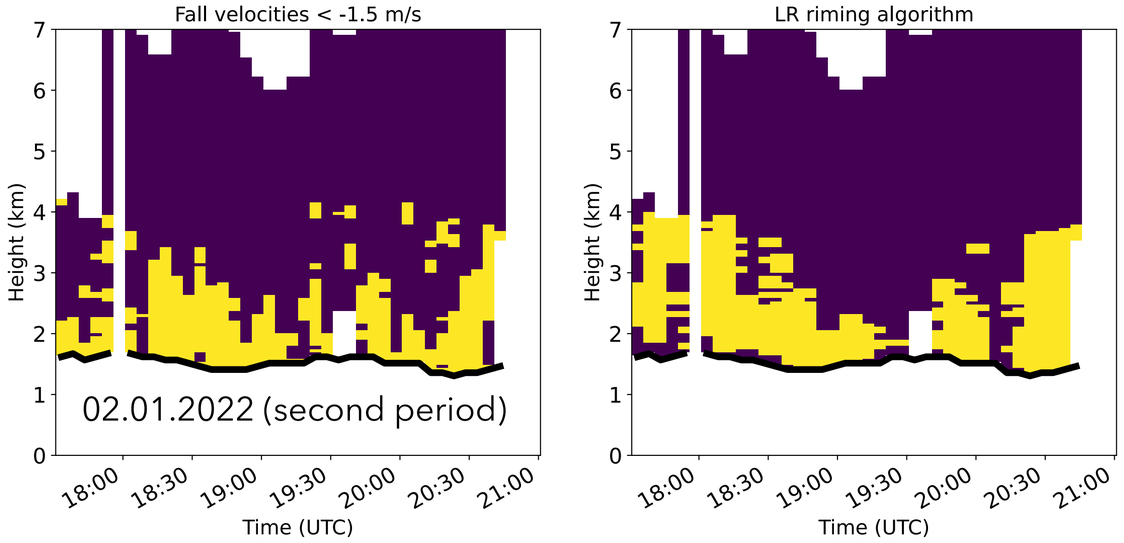
F1 score: 0.55, accuracy: 0.876



Jaccard coefficient: 0.43

F1 score: 0.6, accuracy: 0.876

LR riming algorithm (most promising)



Case with intense vertical air motion

Mean RMF: 0.492

Mean fall velocity: -1.6 m/s

Jaccard coefficient: 0.469

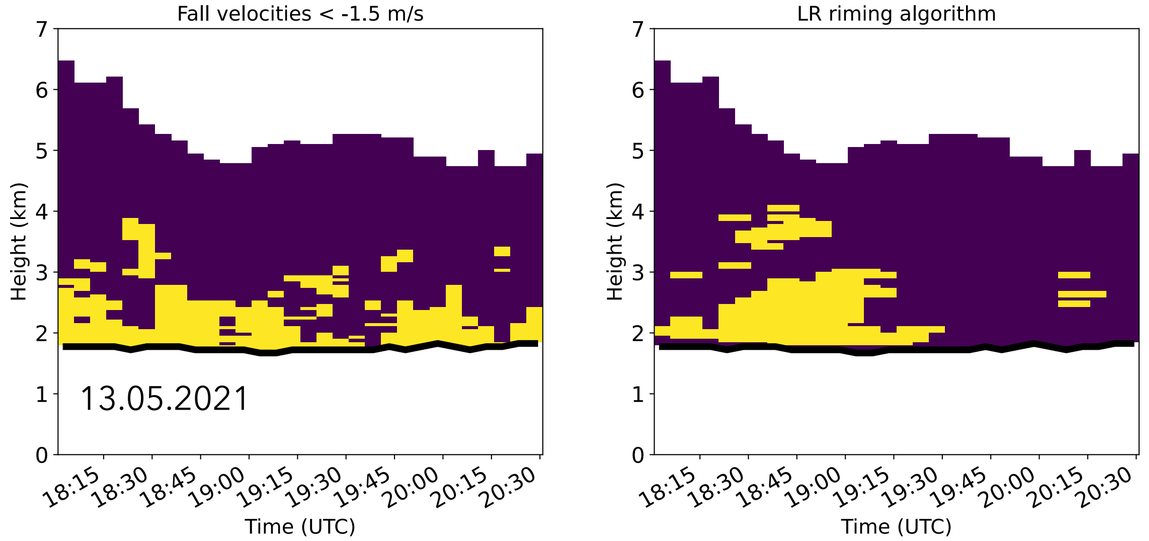
F1 score: 0.68, accuracy: 0.853

Mean RMF: 0.42

Mean fall velocity: -1.45 m/s

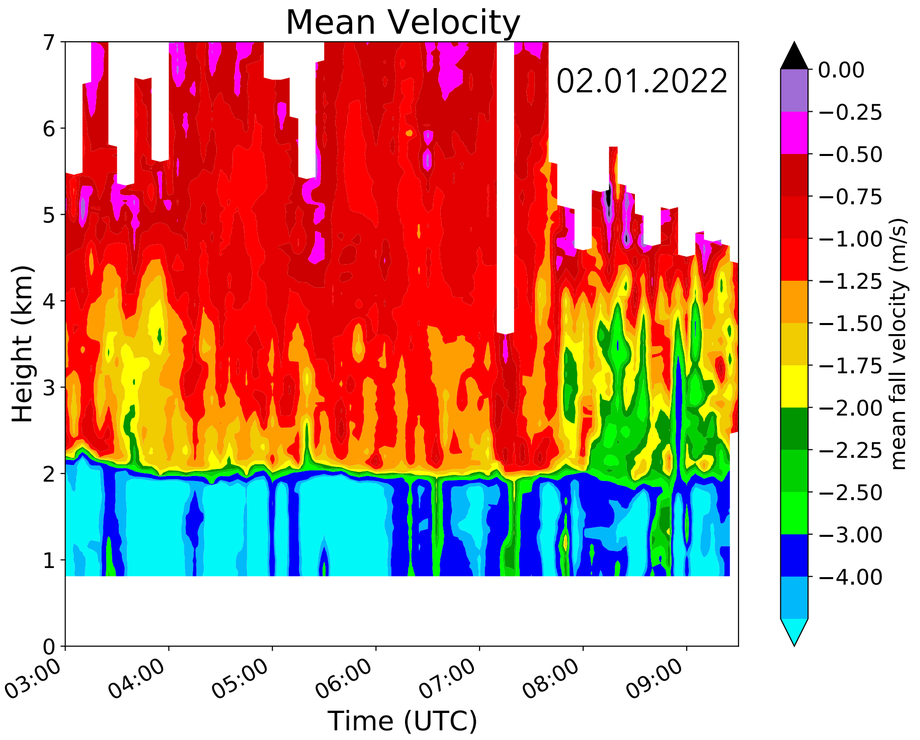
Jaccard coefficient: 0.236

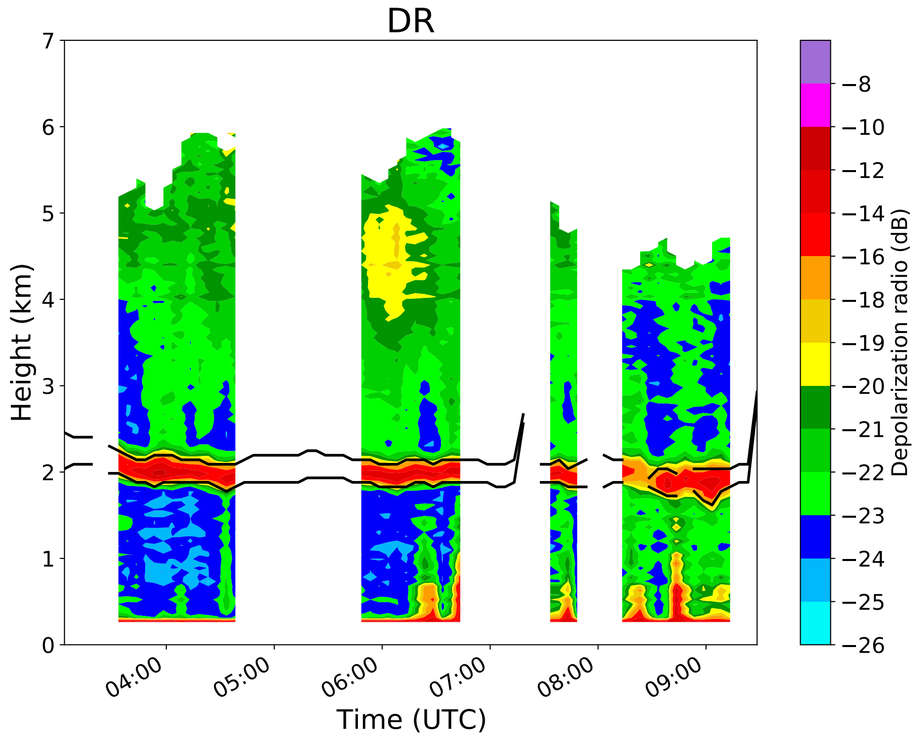
F1 score: 0.38, accuracy: 0.786



How do we find riming periods?

Via saggy periods routine





Find sagging via first derivation of ML top and bottom (rolling mean) + previous time step (precursor)

Data only above ML

Conclusion

Automatic filtering algorithms to find intense riming periods where aggregation can be mostly excluded. They are applicable all over Germany.

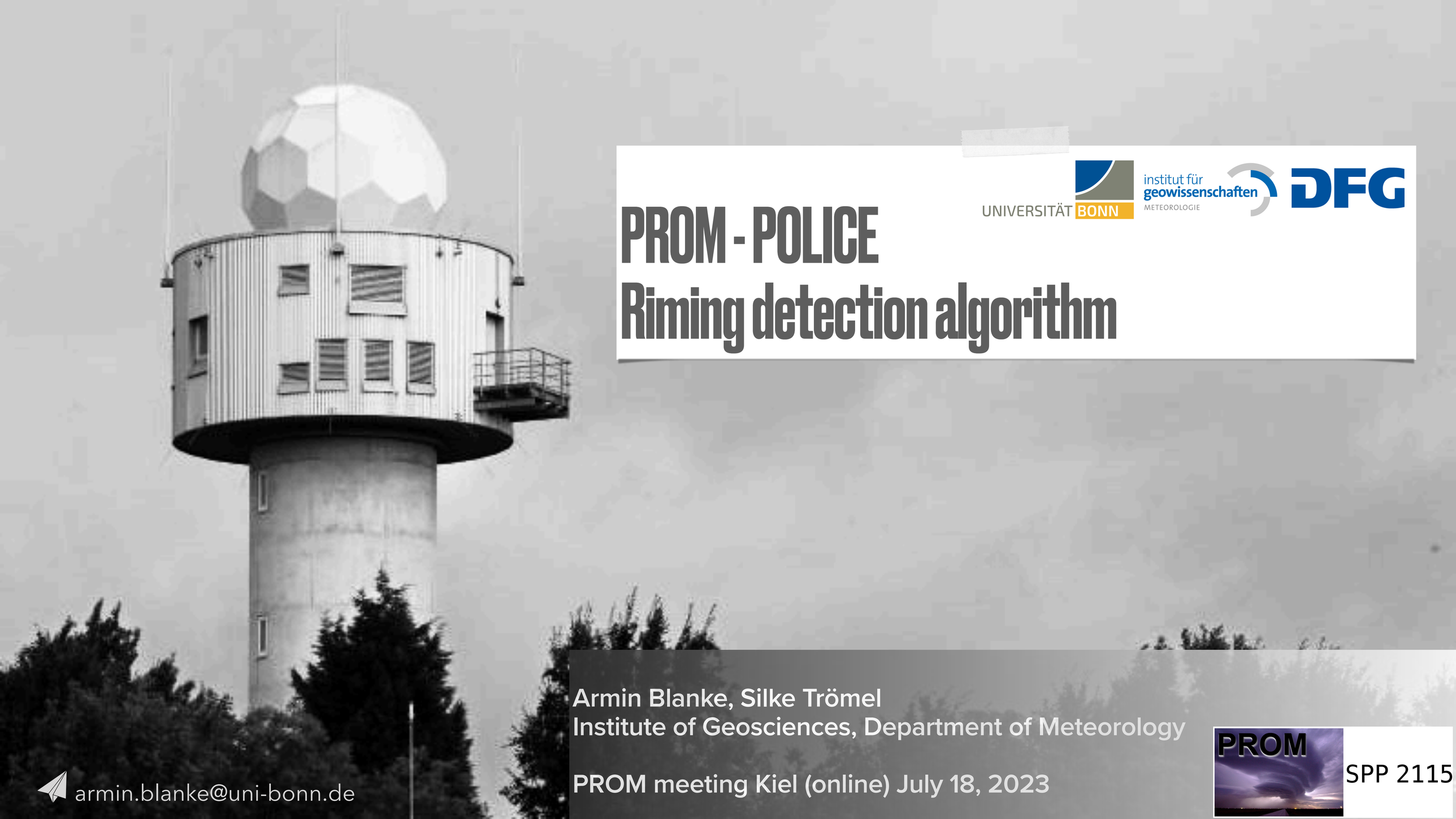
- Algorithms are capable of finding rimed periods in a stratiform case
- LR algorithm most promising, QDA algorithm overestimates riming, threshold based algorithm too strict (overfitted)
- Saggy periods match nearly any DR <= - 22 dB at C-band but do not capture all periods with fast falling particles (sagging of the ML could be used as supporting factor)

Challenges

- Convection/vertical air motion and spatio-temporal mismatches between fall velocities from birdbath scans and QVPs can lead to missing or unreliable evidence for identified riming cases
- Possibility of overlapping processes at around 1.5 m/s fall velocities (light riming, rimed aggregates)

Further work

- Check the performance of different algorithms on more cases



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