Melting Layer and Riming Detection from Vertically Pointing C-band Radar Observations

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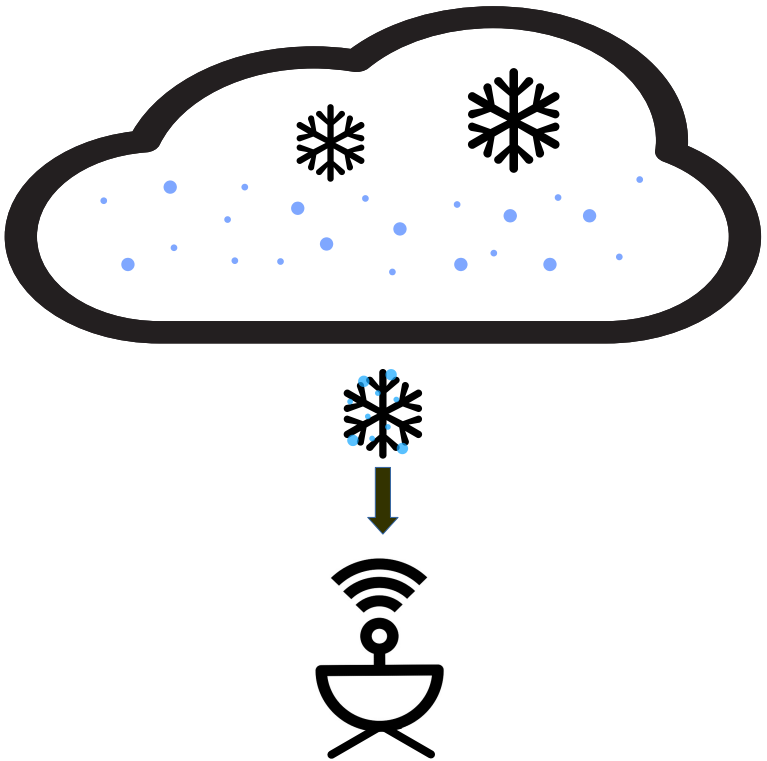
PrePEP Conference: Precipitation Processes – Estimation and Prediction
20th March 2025

Contact: Paul Ockenfuß (paul.ockenfuss@physik.uni-muenchen.de)

Rimed Ice in Doppler Images



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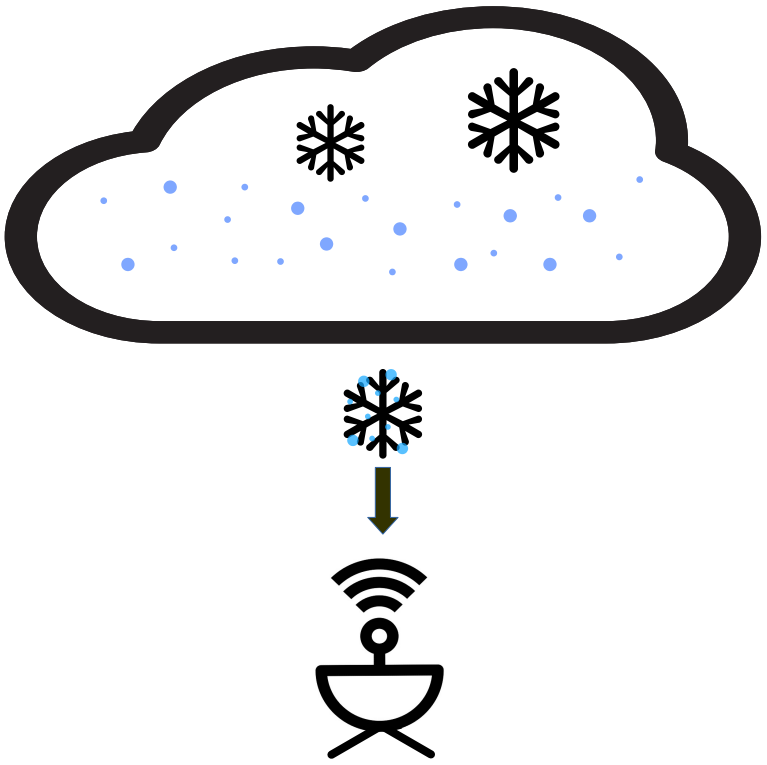
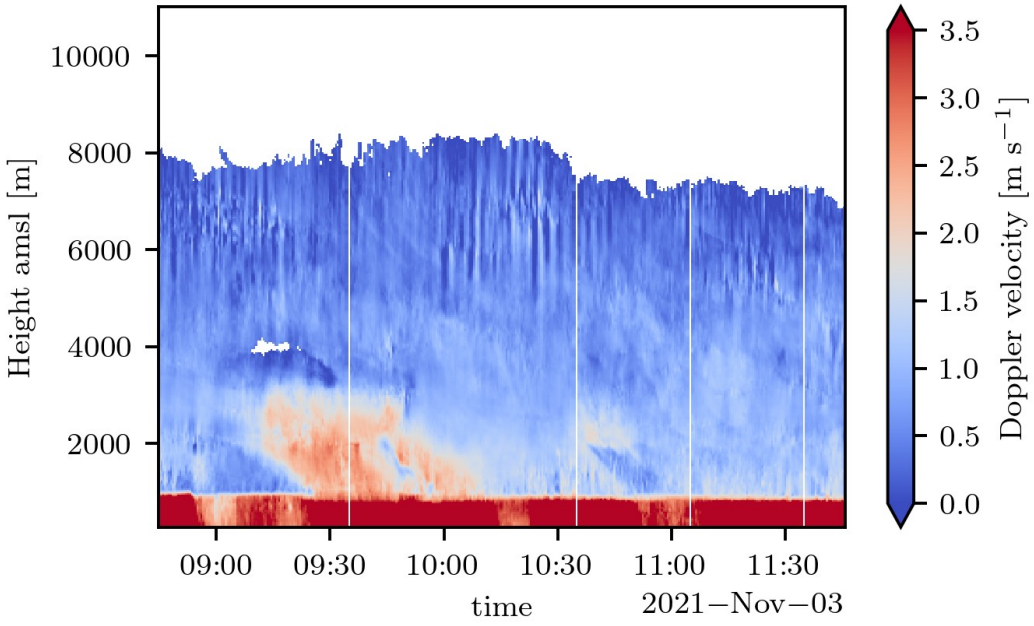


Ka Band Cloud Radar



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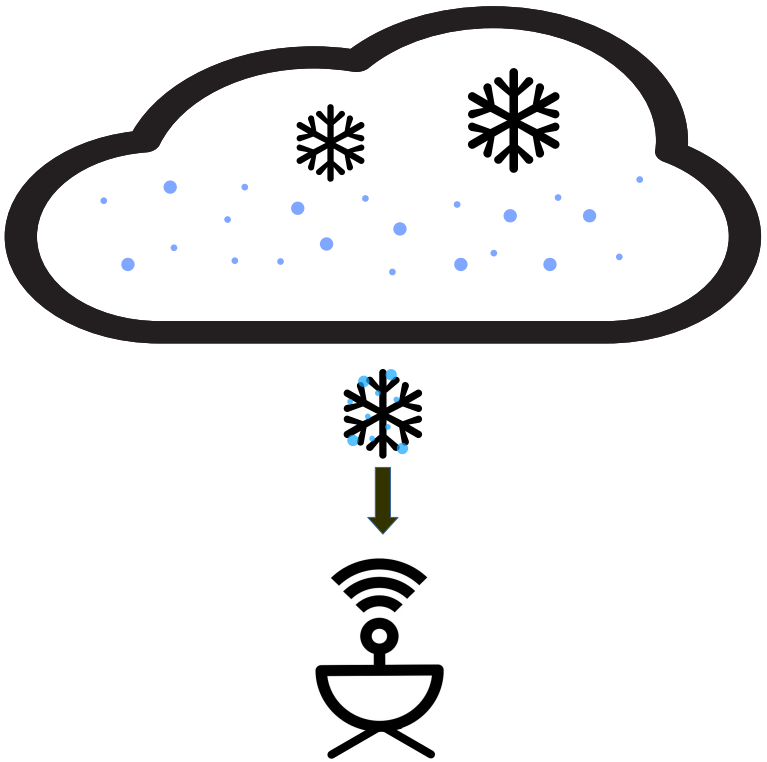

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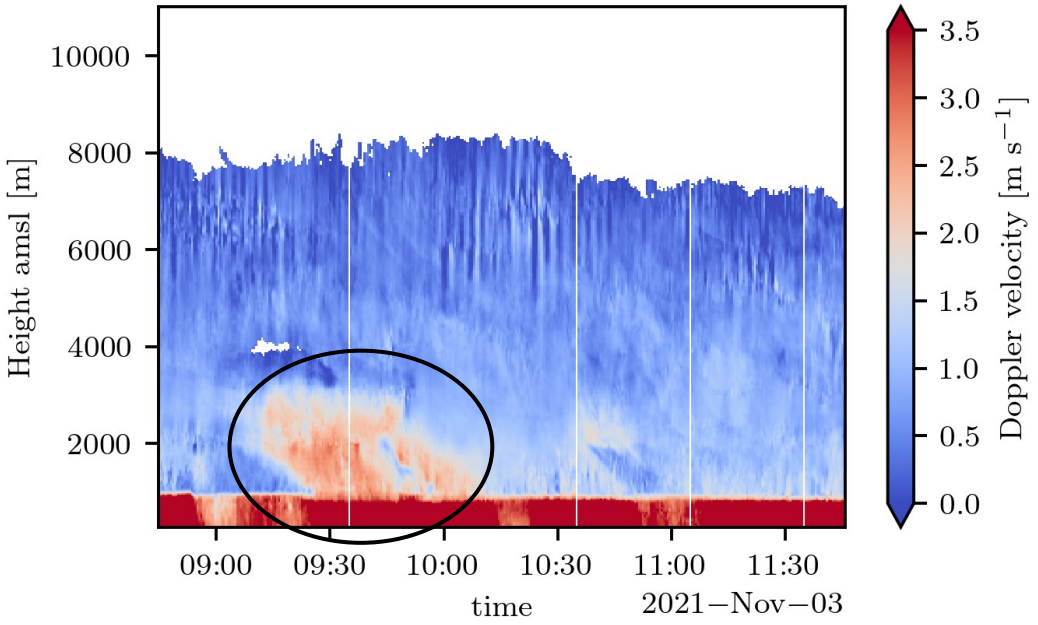

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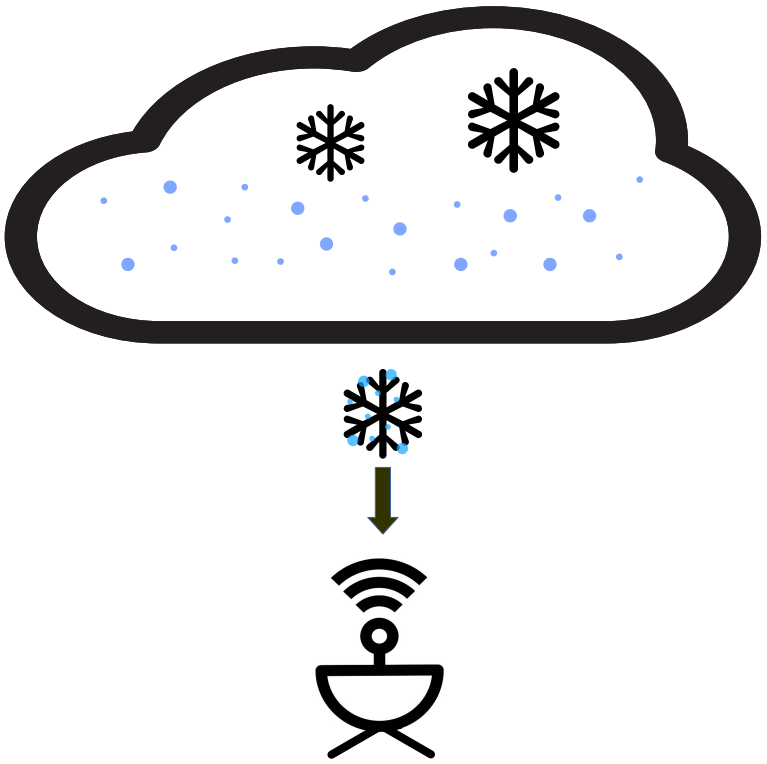

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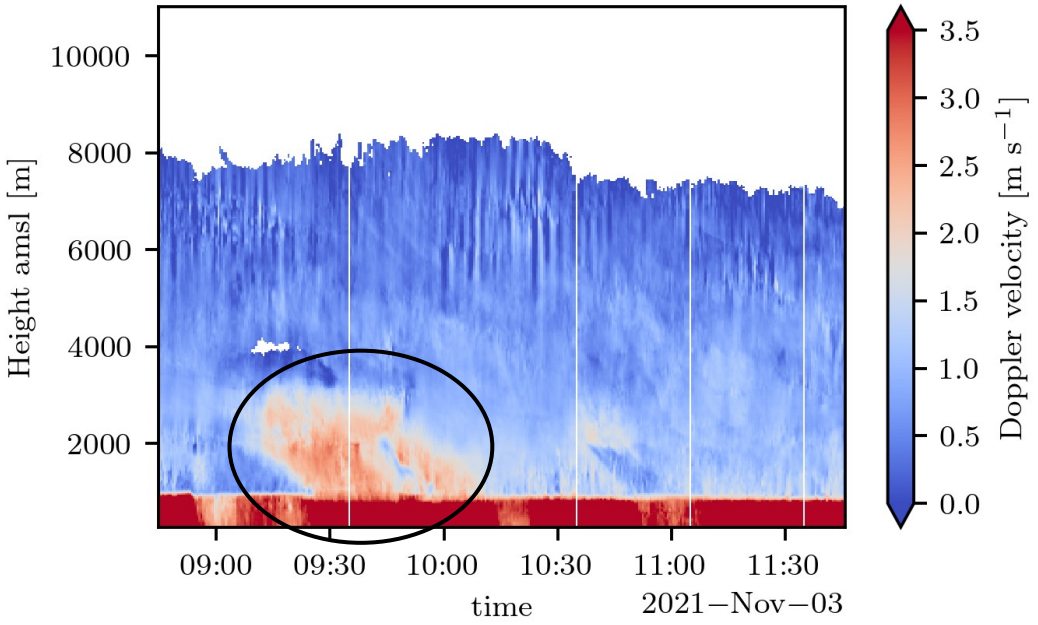

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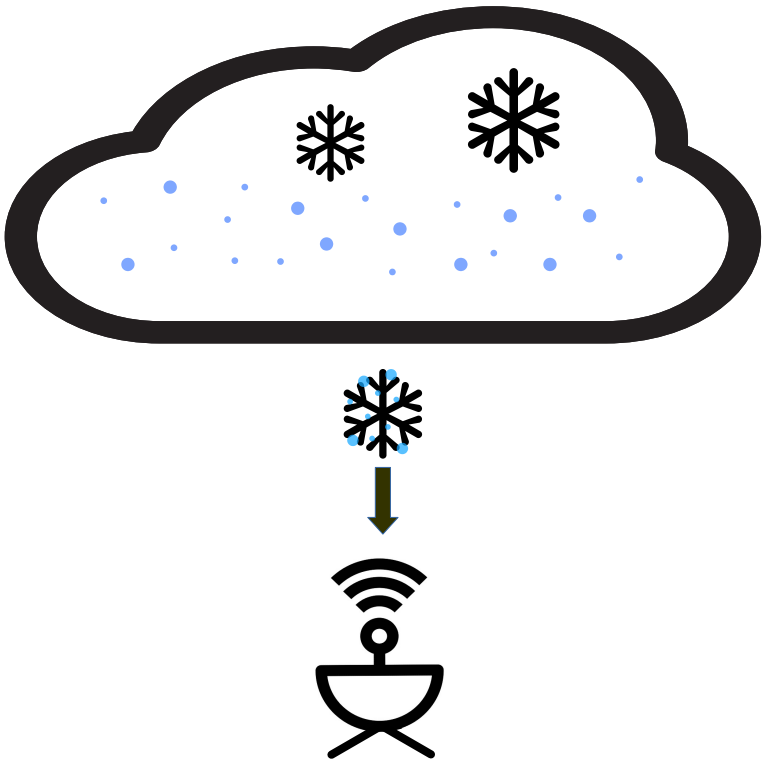

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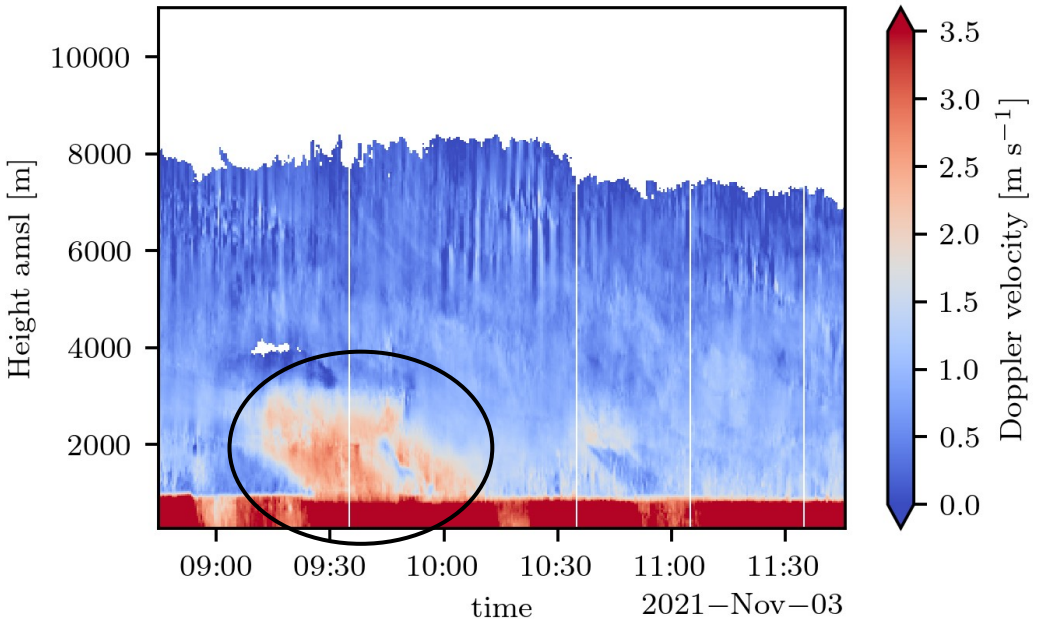

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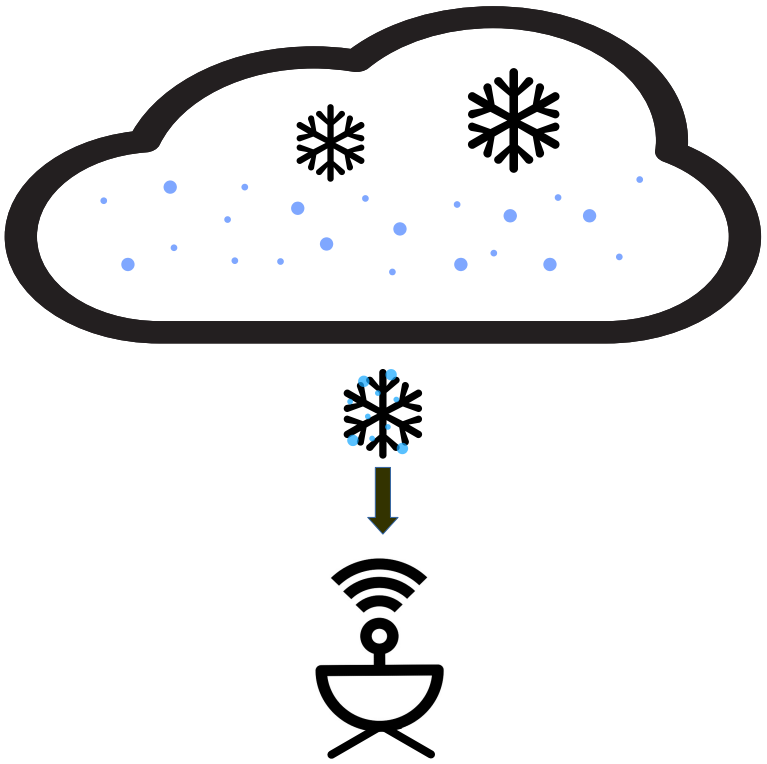

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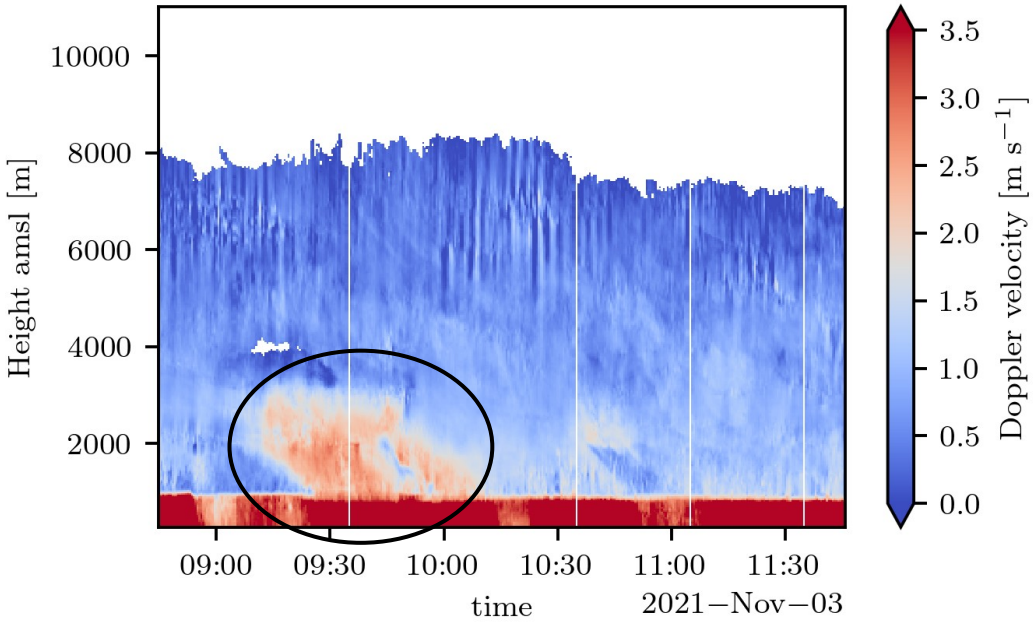

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Operational C-Band Birdbath Scan

Overview article: Frech at el., submitted to BAMS

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- 90º Elevation

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- Introduced for ZDR calibration
- Vertical resolution: 25 m sampling, 60 m intrinsic, up to 13.2 km height
- Time: One profile every 5 min

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Product Transfer

Challenges when transferring an existing product **from Cloud Radars to the Operational Birdbath Scan**

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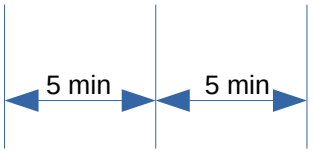

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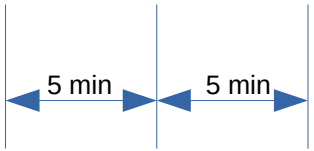

- No Additional Data
  (e.g. Lidar, Radiometer, Model Profiles)

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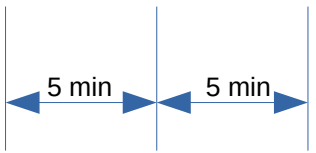
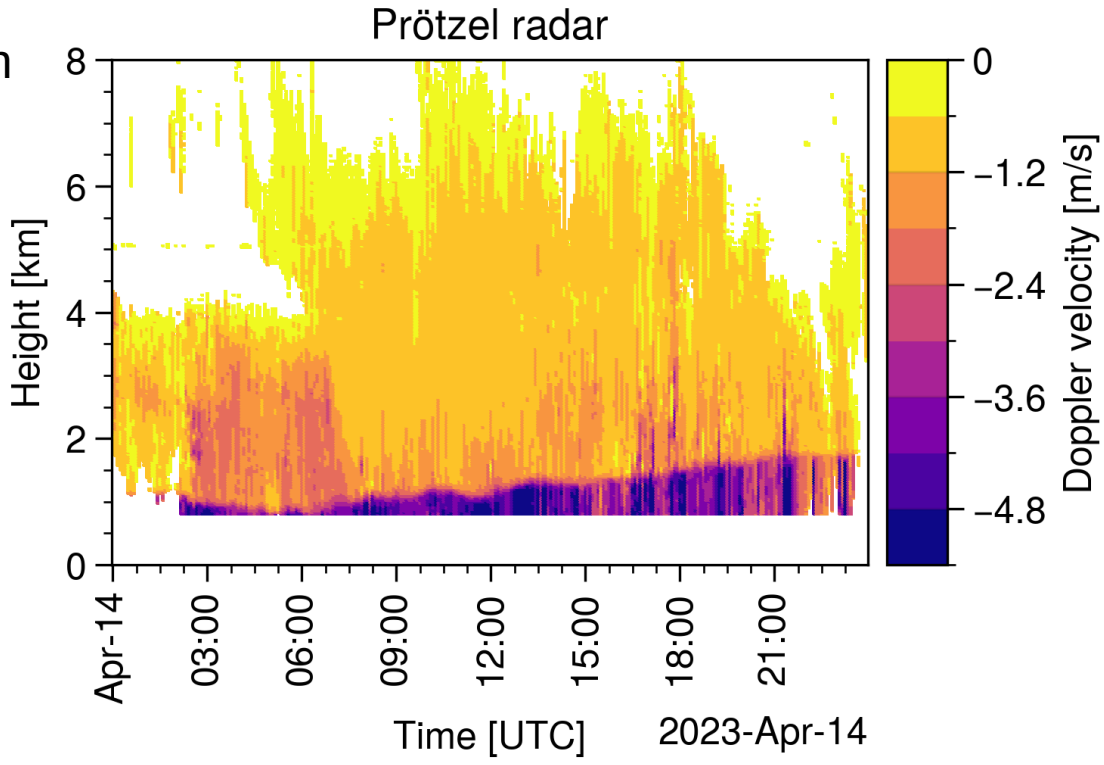


Impact of those points can be quantified by **comparing** the results of:
- the **original** retrieval and data “as is”
- the new retrieval applied to **coarsened cloud radar data** (and no additional information)

Example: Melting Layer Detection

Original: Rain vs ice discriminated using **Cloudnet Target Categorization** + High resolution **model profiles**

Now: Detect melting layer from Doppler velocity



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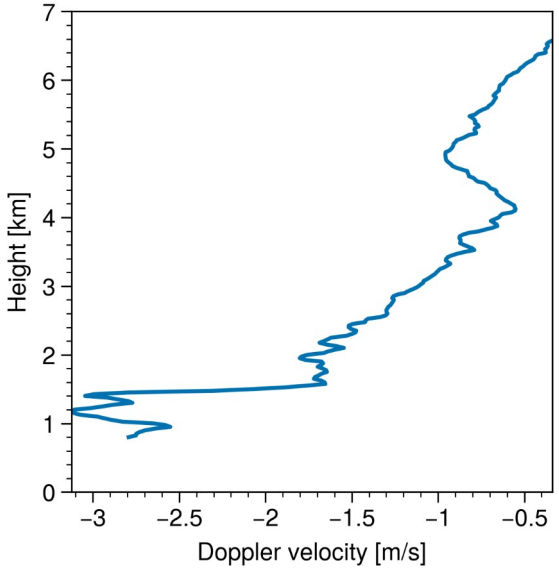

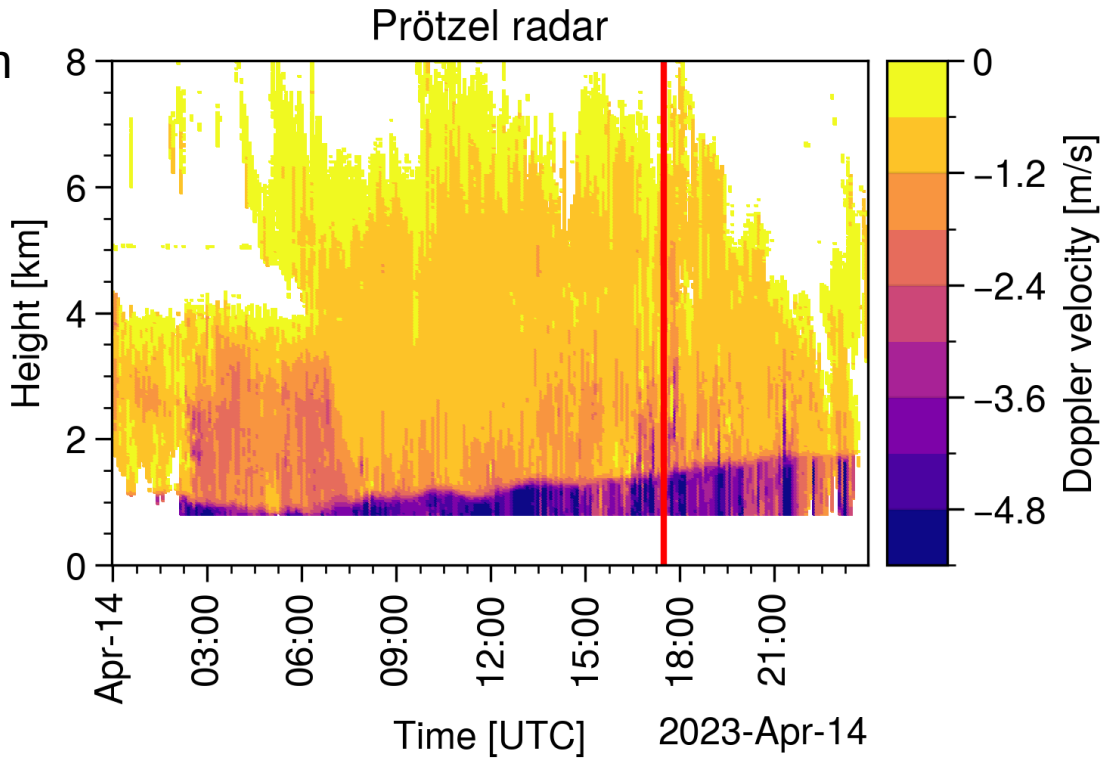

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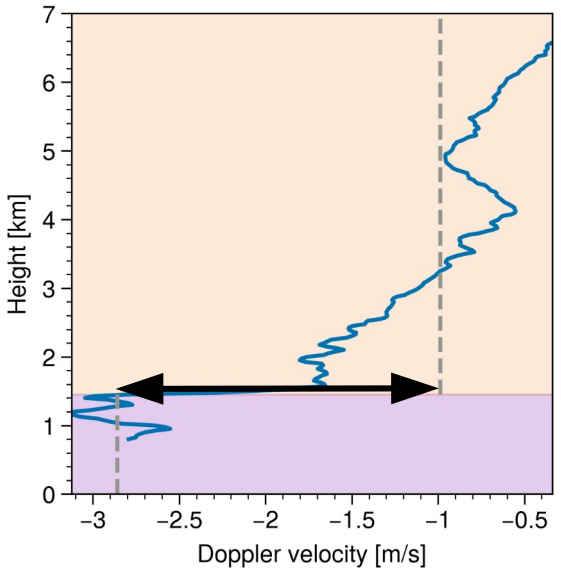
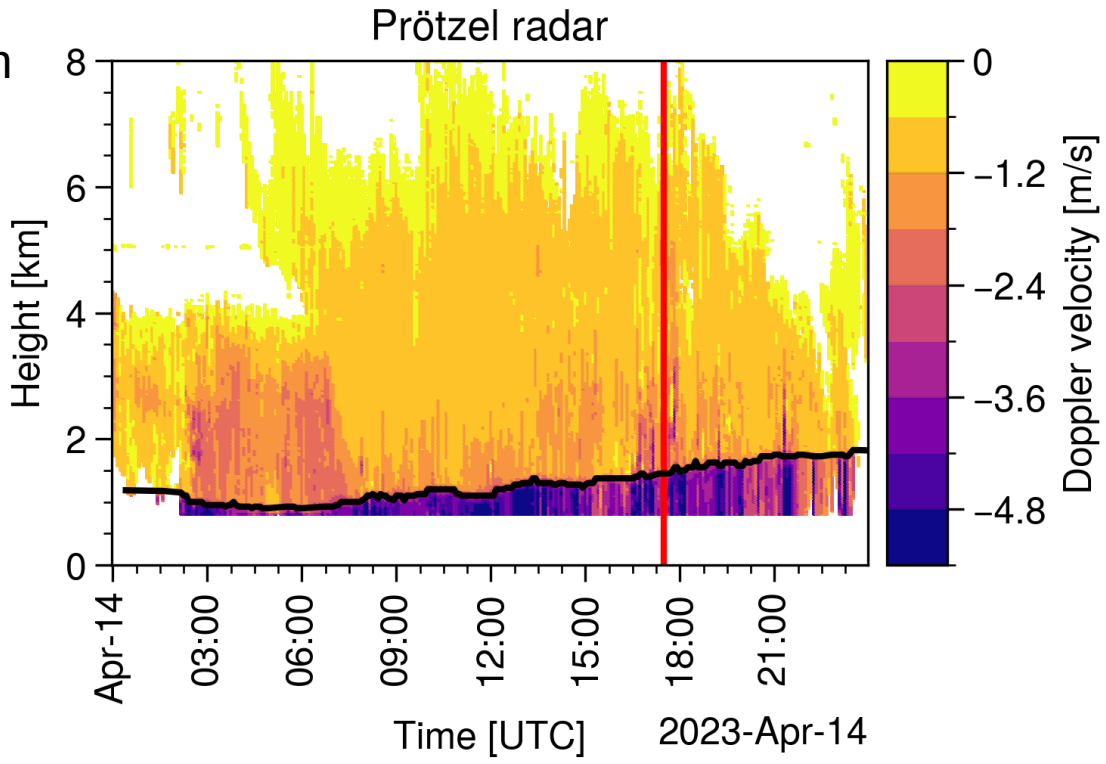
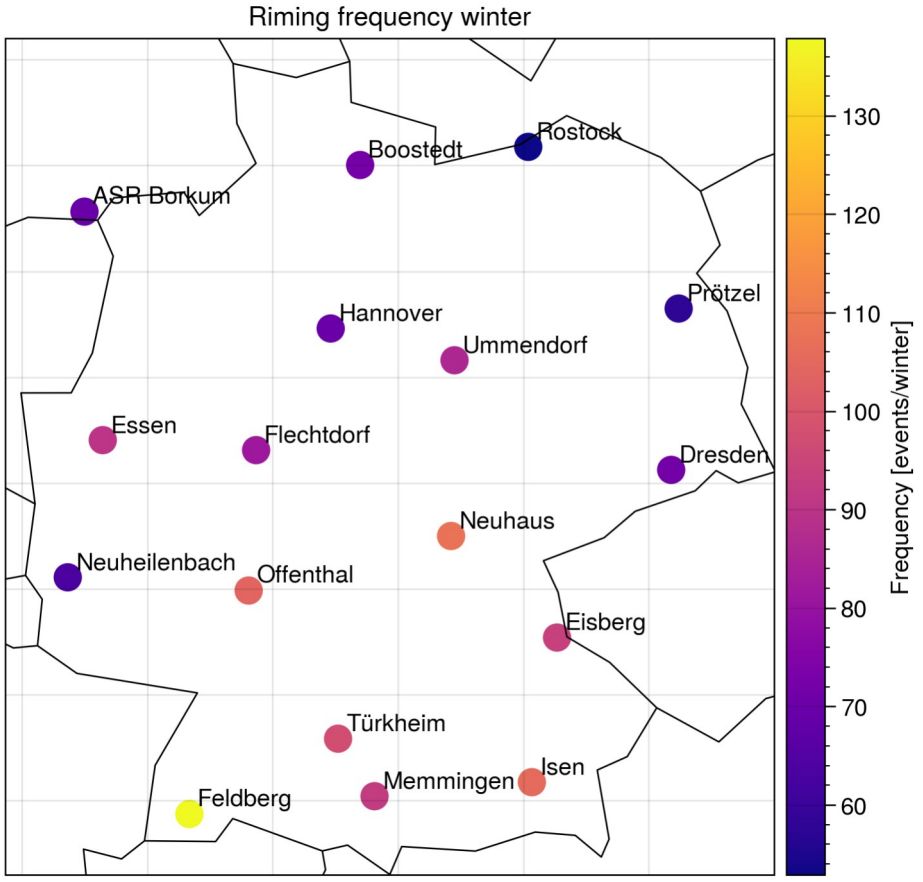




Spatial Riming Distribution



Number of riming detections per winter (Nov-Apr); Avg. 2021-2024

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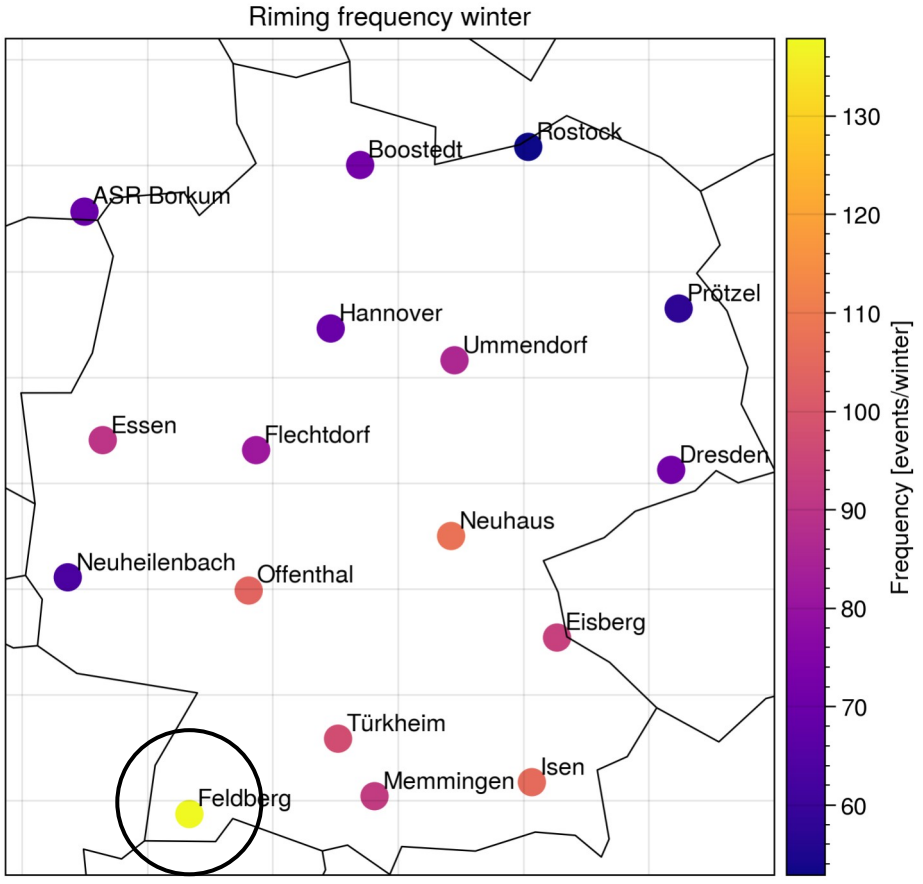

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Precipitation Distribution

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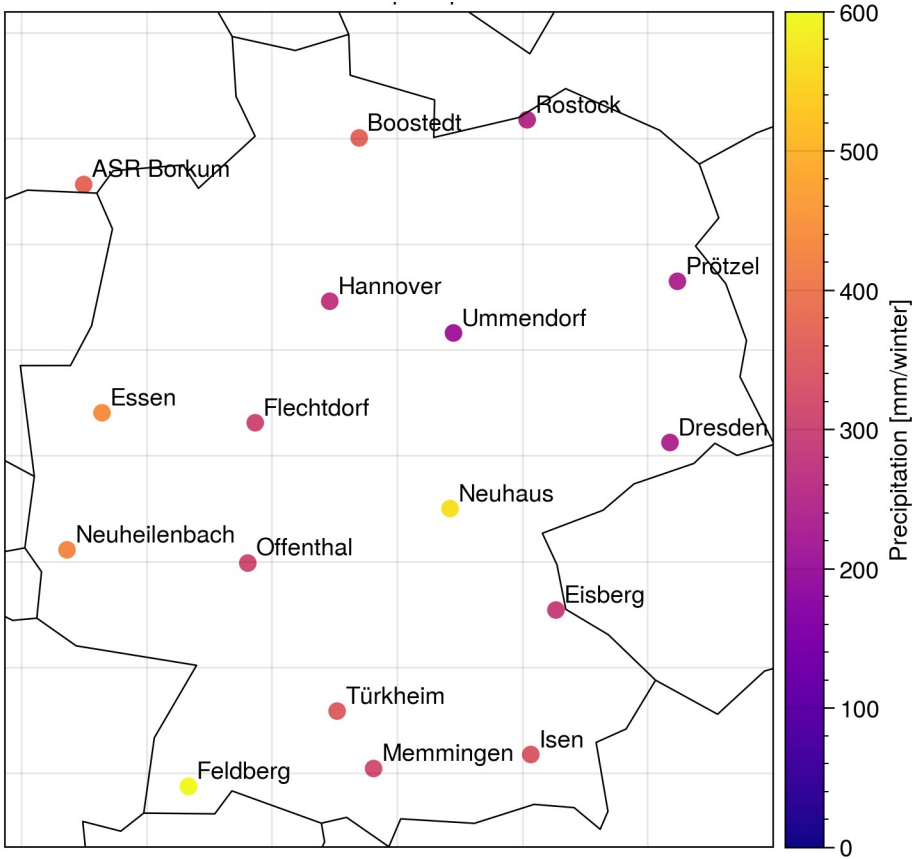

Nov. – Apr. avg. precipitation (2005-2025),
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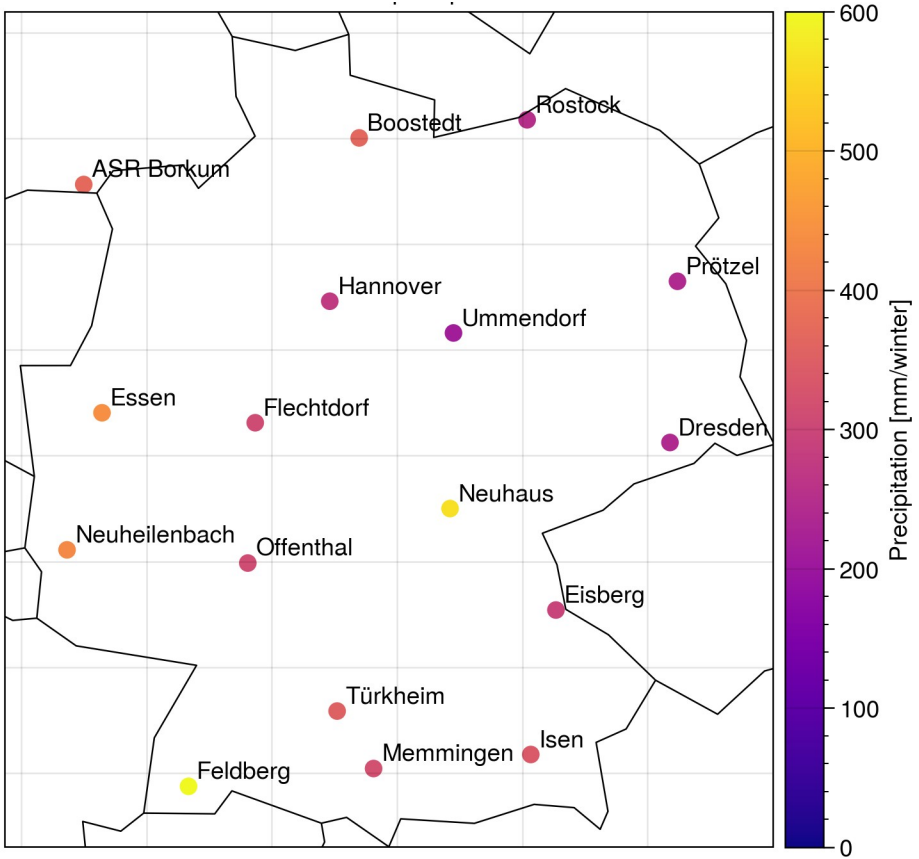

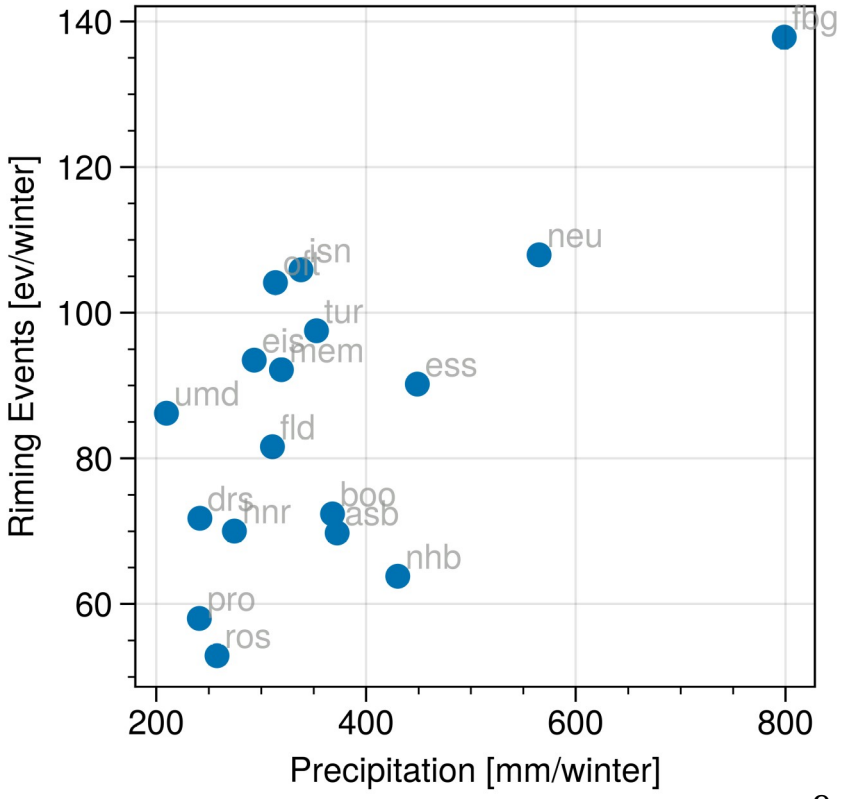

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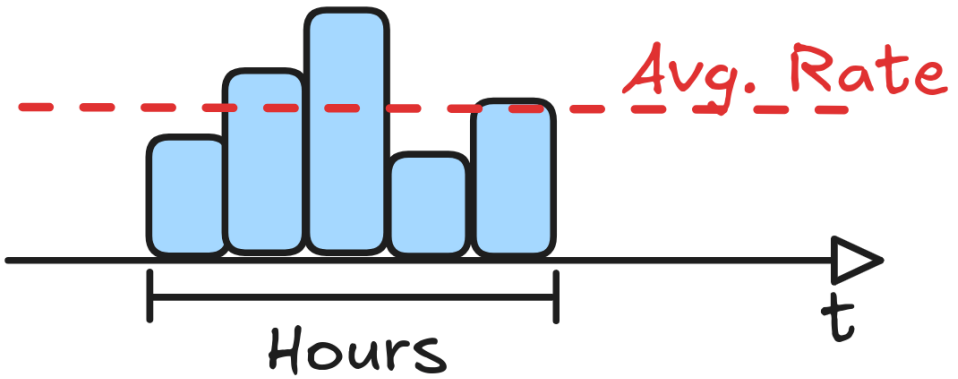
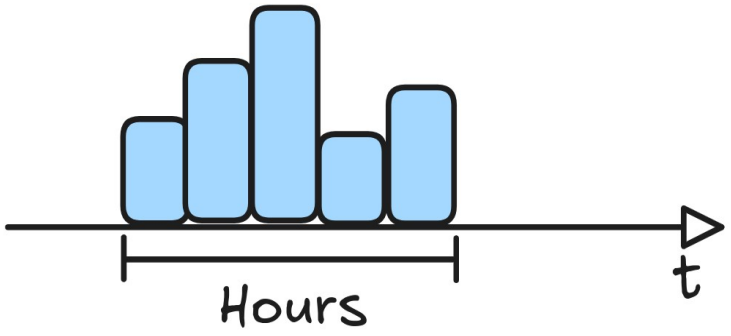
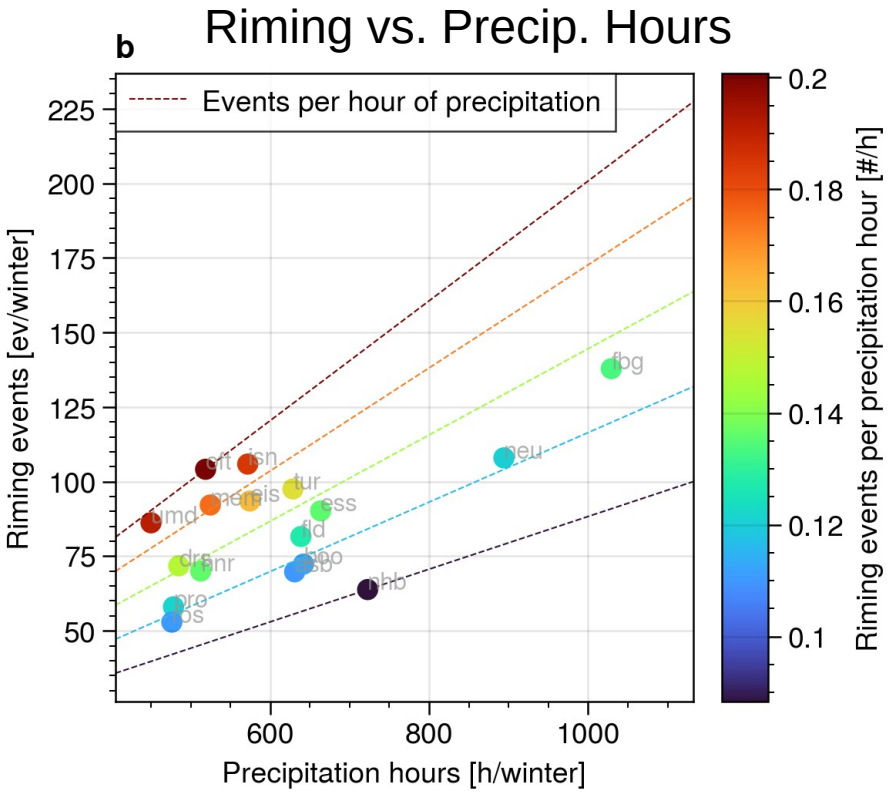


Total = Hours * Rate

Riming and Precipitation Hours





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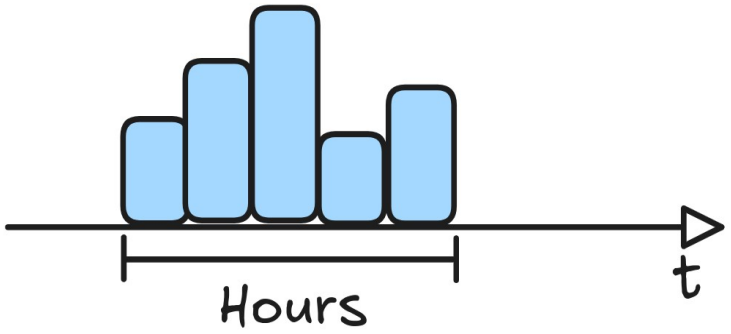

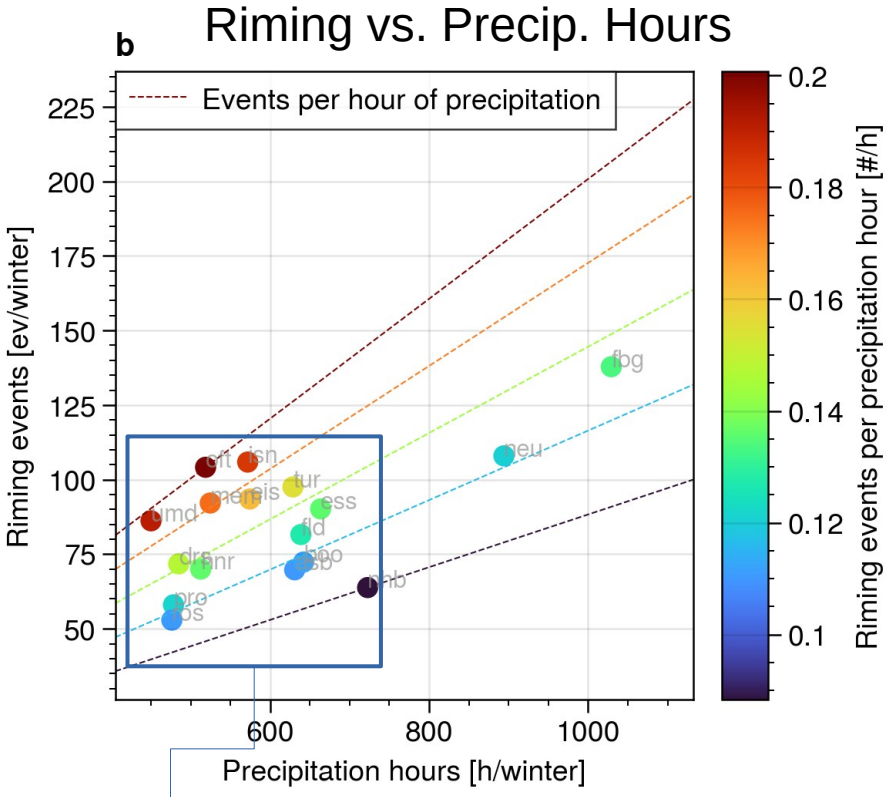

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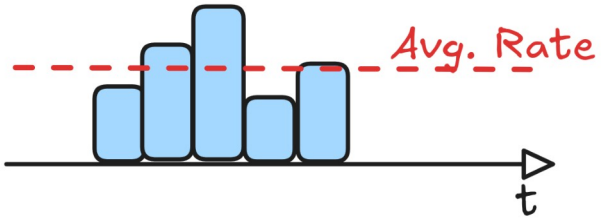

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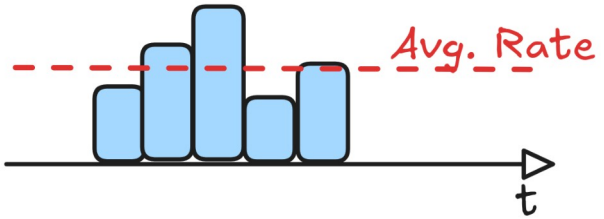

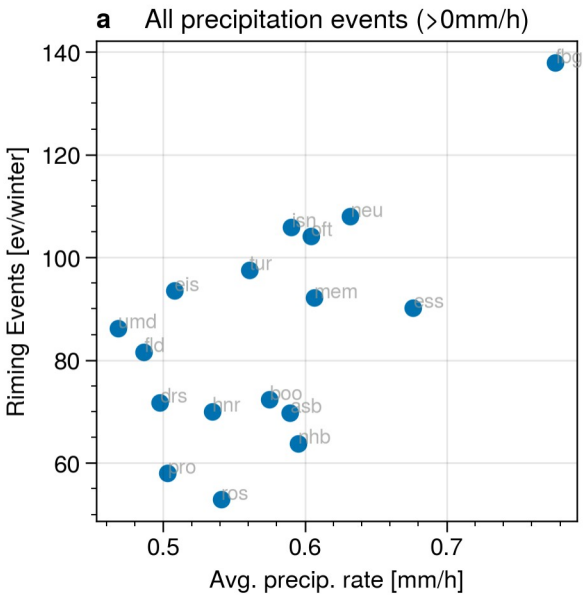

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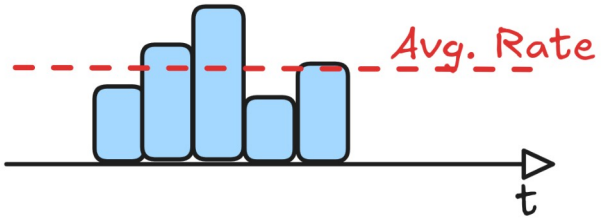

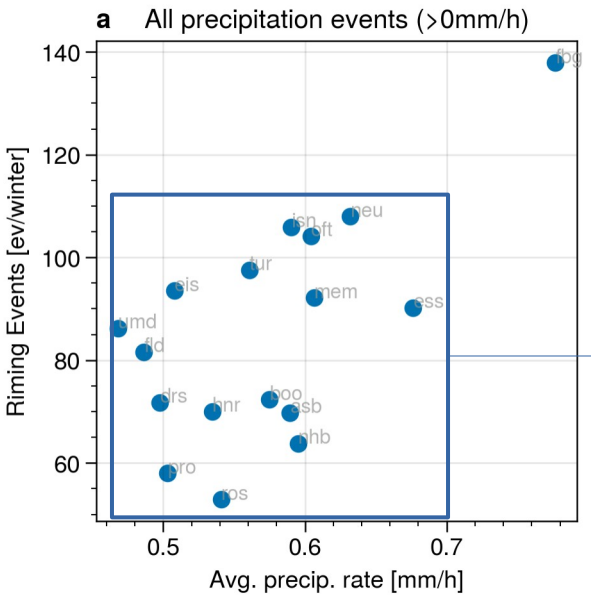

Pearson Correlation: 0.38

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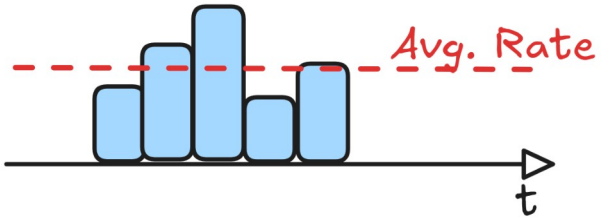

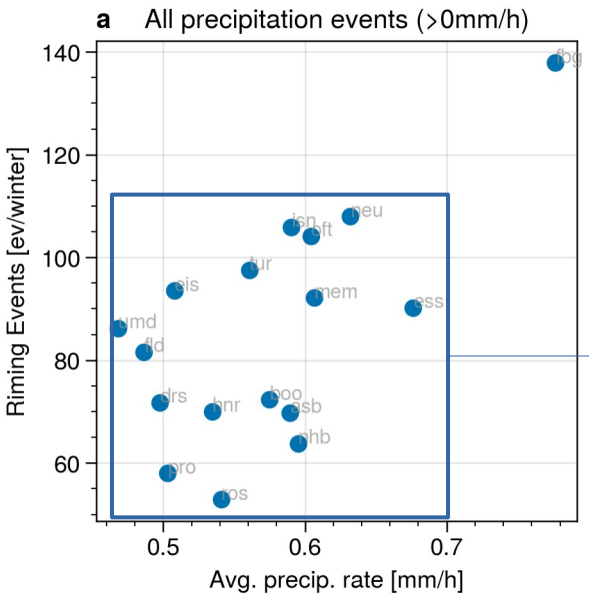

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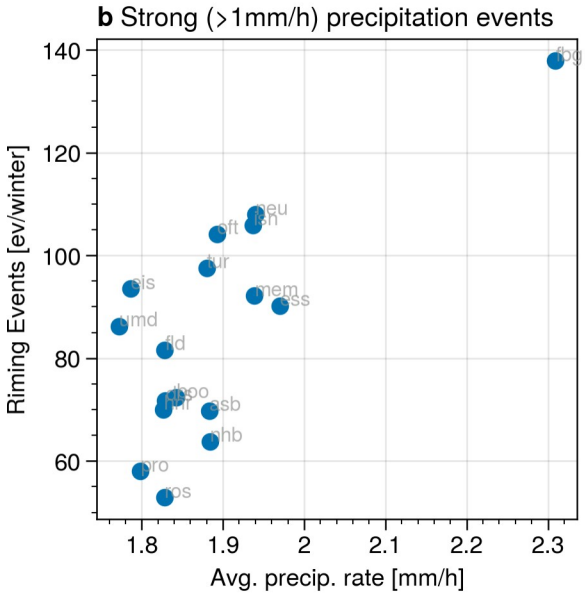

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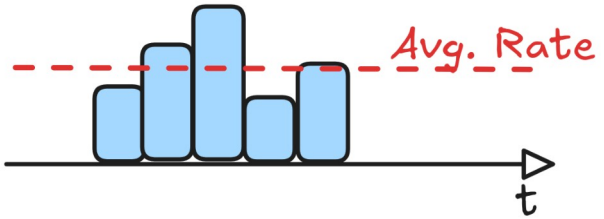

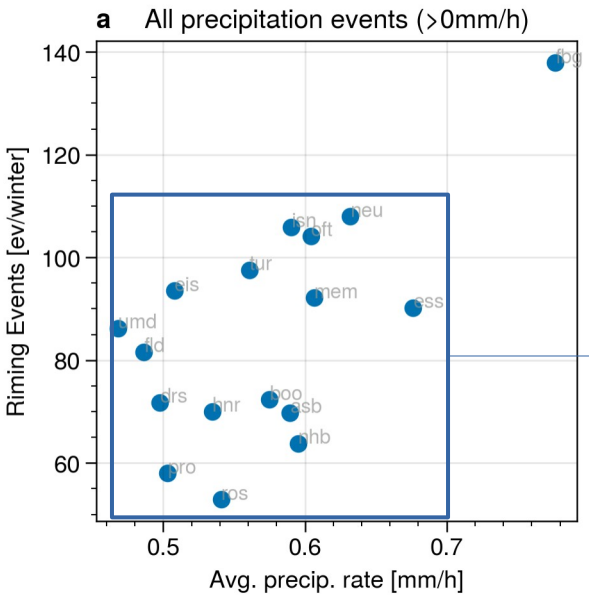

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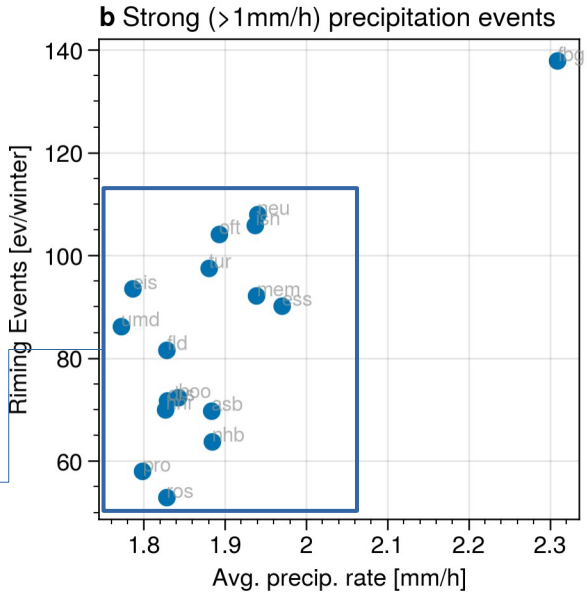


Conclusion

What we did
Transferring our existing riming detection to the operational C-Band birdbath scan
We found
Sites with more riming events exhibit stronger precipitation!
(Theory: Orographic lifting enhances liquid water which favors riming and creates precipitation)

This illustrates the advantages when doing science based on operational Radars
- Homogenous spatial distribution of radar sites over Germany
- Huge amounts of data → Able to reveal trends even in noisy data

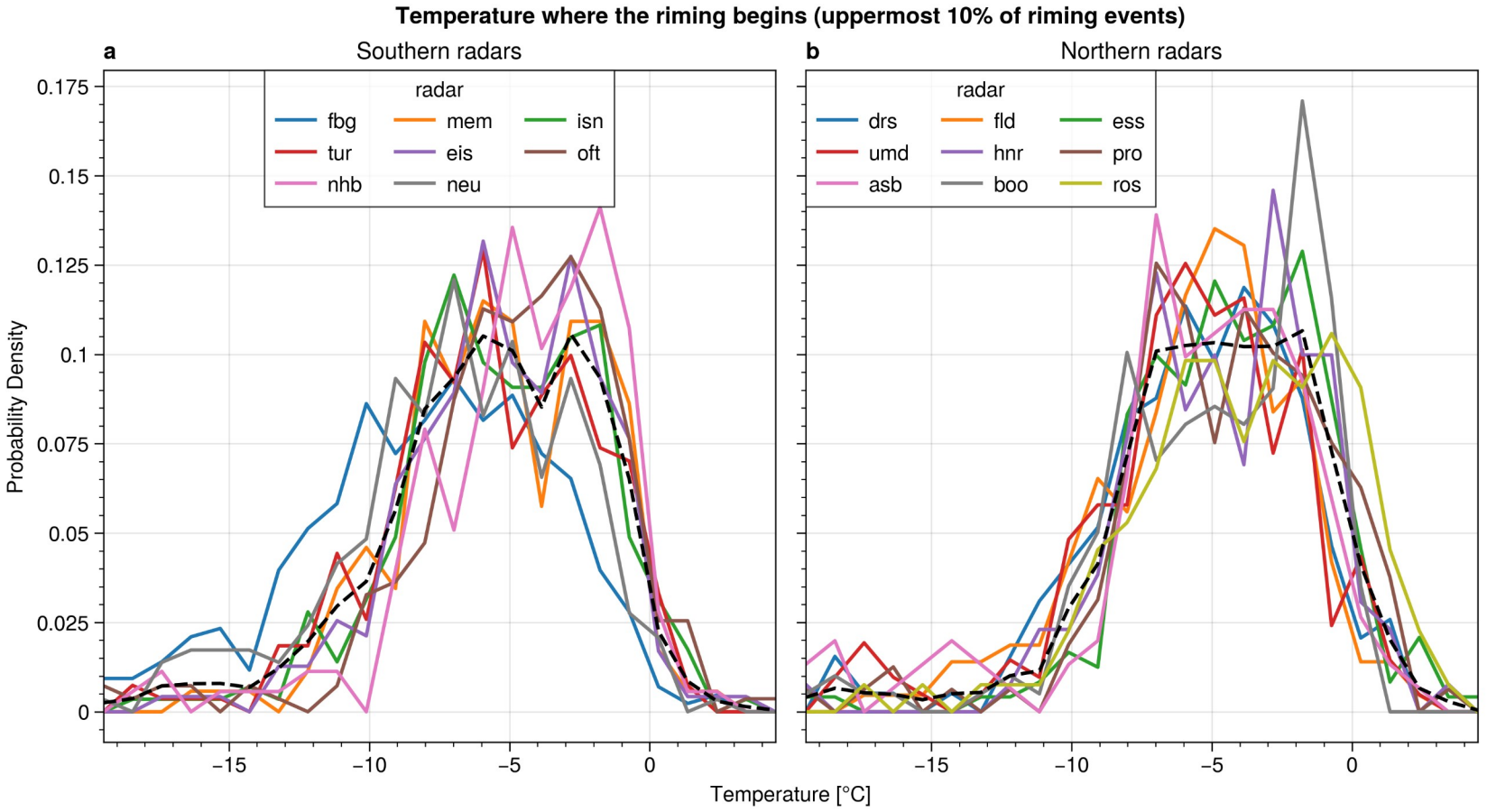
Current Limitations and Future Work
- Compared only climatologies here
- Correlation does not prove causality

My wish
More instruments at radar sites! (E.g. surface weather station)

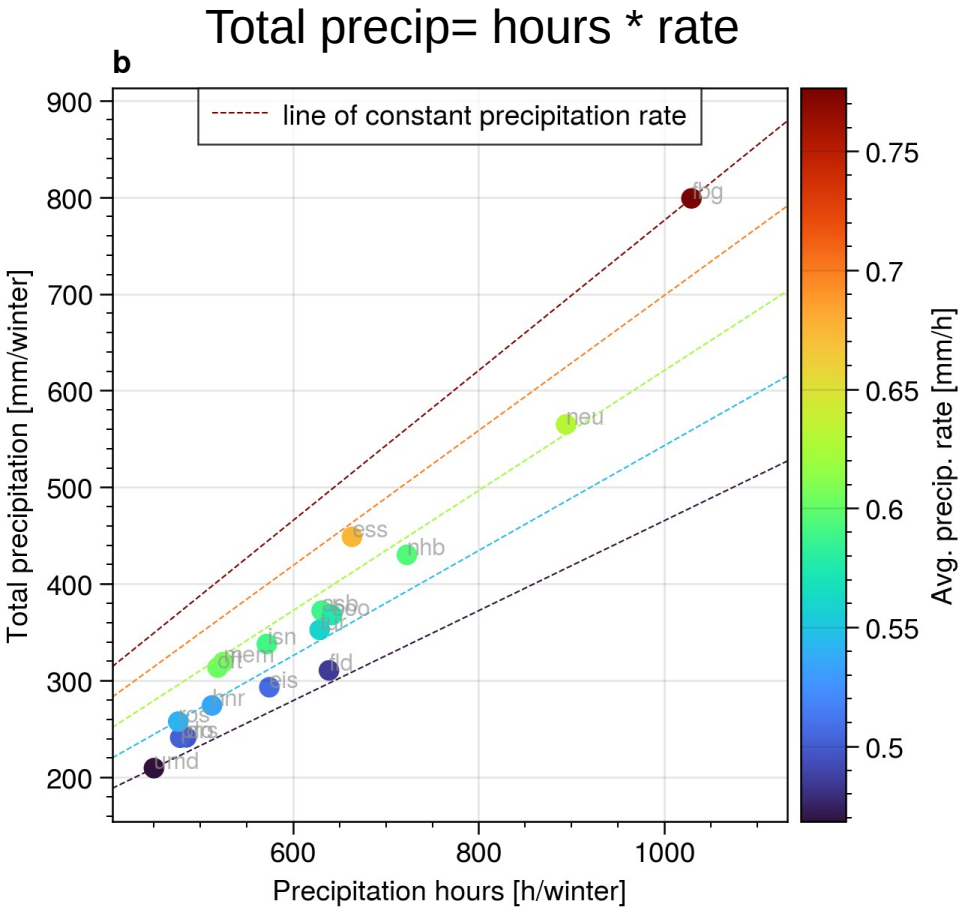
Paul.ockenfuss@physik.uni-muenchen.de

Additional Slides

Temperature where Riming Starts



Correlation Hours vs Rate



Radar Topography