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Techniques for better exploiting cloud radar Doppler spectra

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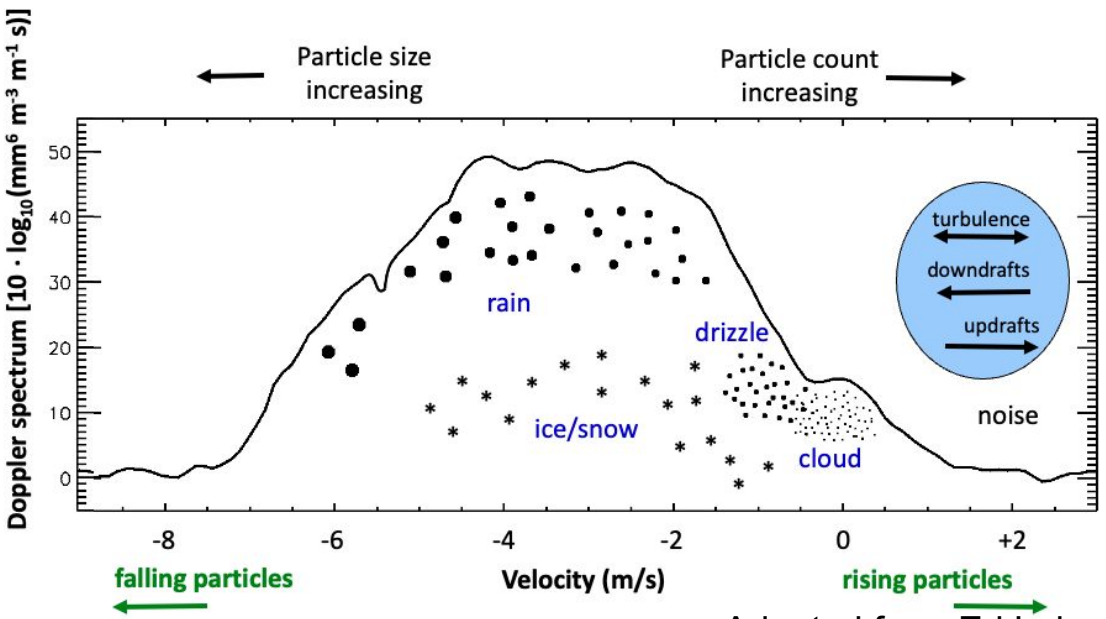
cloud radar Doppler spectra…

…contain valuable information about cloud microphysics

… are also impacted by atmospheric turbulence and dynamics

… are recorded and saved at each time and height



Adapted from Ed Luke

need for cloud radar Doppler spectra processing methods

fast **adjustable** **open-source**

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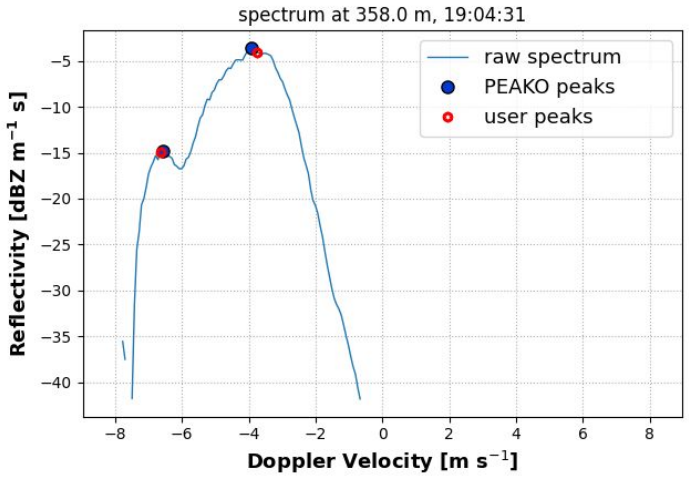
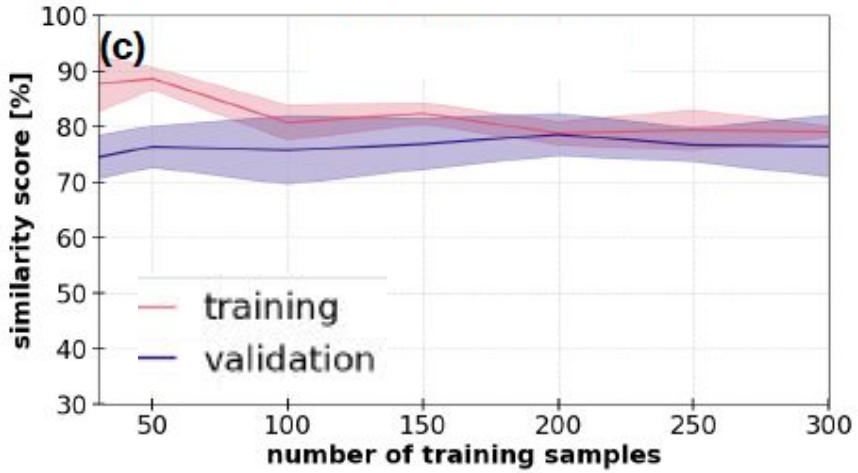
PEAKO and peakTree: Tools for cloud radar Doppler peak analysis

PEAKO: supervised machine learning tool for PEAK detectiOn

peak detection function based on Python scipy signal processing
+ time-height averaging and smoothing

finds the best parameters to match peaks marked in spectra by a human





around 200 spectra required for training

***adjustable** to different radar systems & settings*

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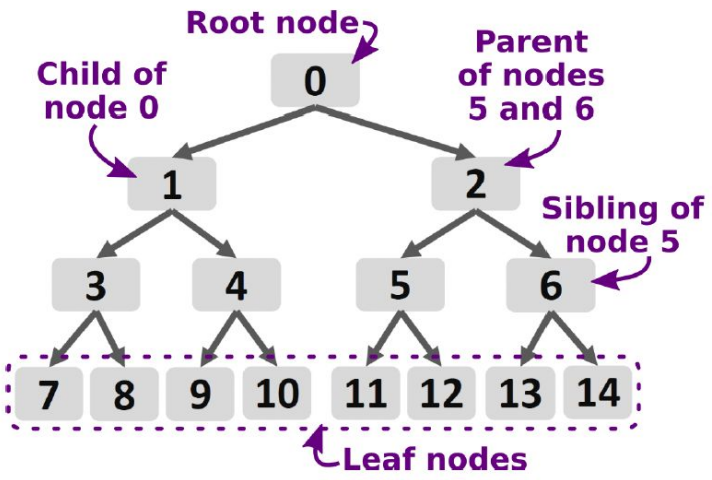
PEAKO and peakTree: Tools for cloud radar Doppler peak analysis

peakTree: tool for detecting, structuring and interpreting peaks

peak detection function: same as in PEAKO
peakTree organizes the detected peaks into a binary tree structure

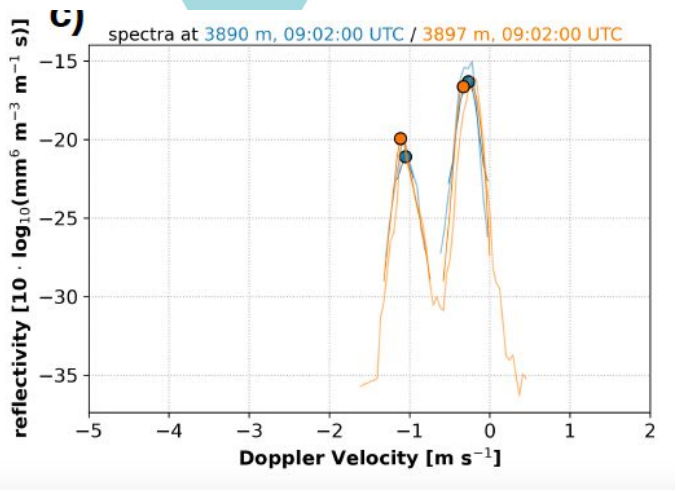
fast: uses numba jit well-suited to process large amounts of data fast

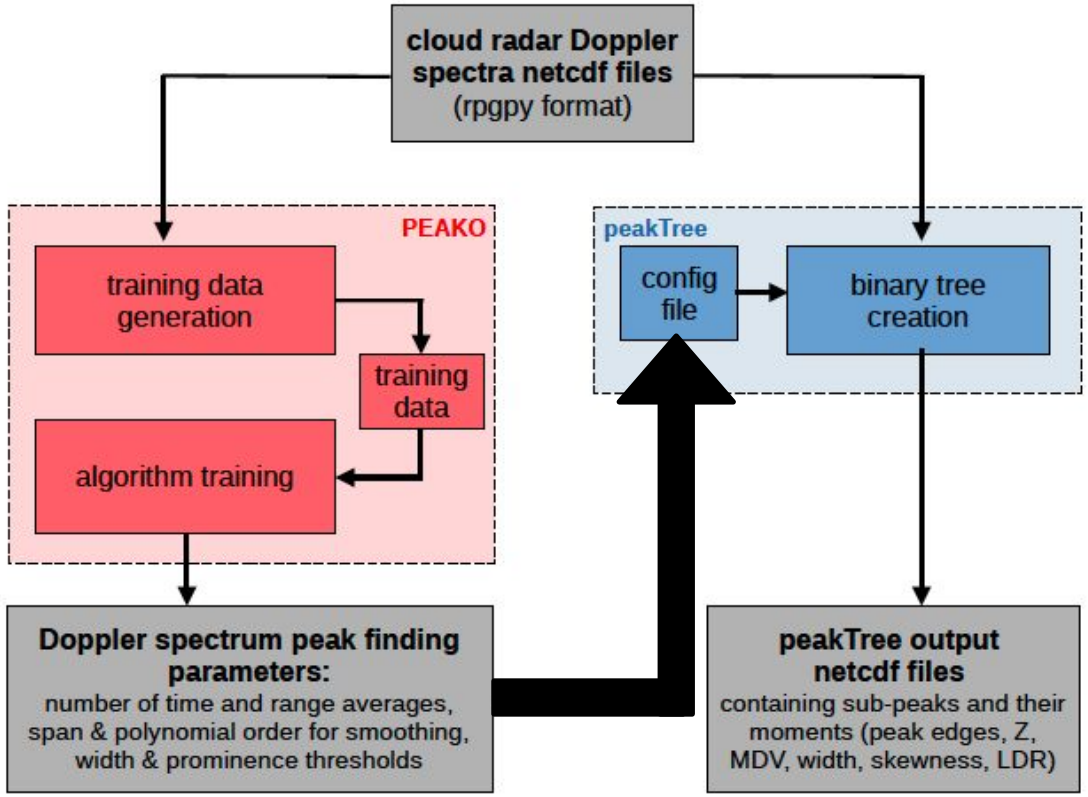


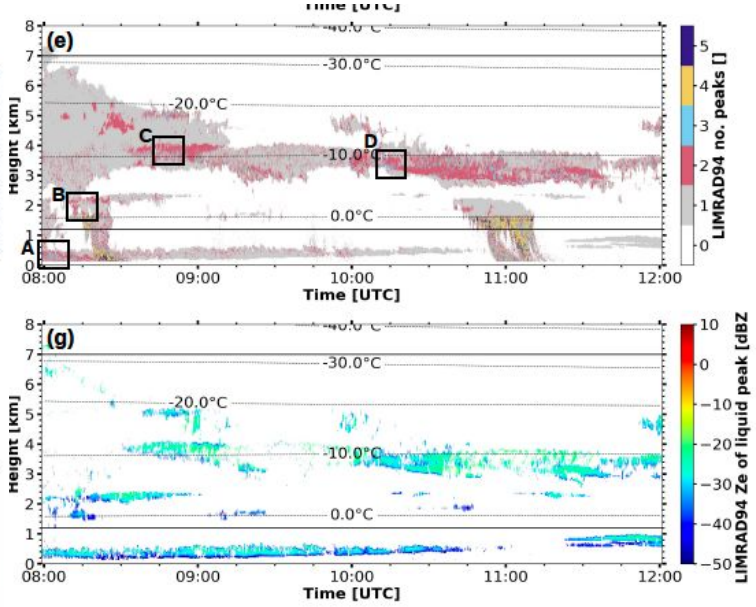
outputs the moments of each node:
- Reflectivity Ze
- mean Doppler velocity MDV
- linear depolarisation ratio
- width

selection of nodes fulfilling certain criteria,
e.g. Ze < -20 dBZ and |MDV| < 0.3 m/s
 liquid cloud droplets

PEAKO and peakTree: Tools for cloud radar Doppler peak analysis







Vogl and Radenz et al. (2024)
In discussion (AMT)

Example: detection of liquid cloud layers

DACAPO-PESO experiment in Punta Arenas, Chile

simultaneous operation of two vertically-pointing Doppler cloud radars

MIRA-35

LIMRAD94

DACAPO PESO

Dynamics, Aerosol, Cloud and Precipitation Observations in the Pristine Environment of the Southern Ocean

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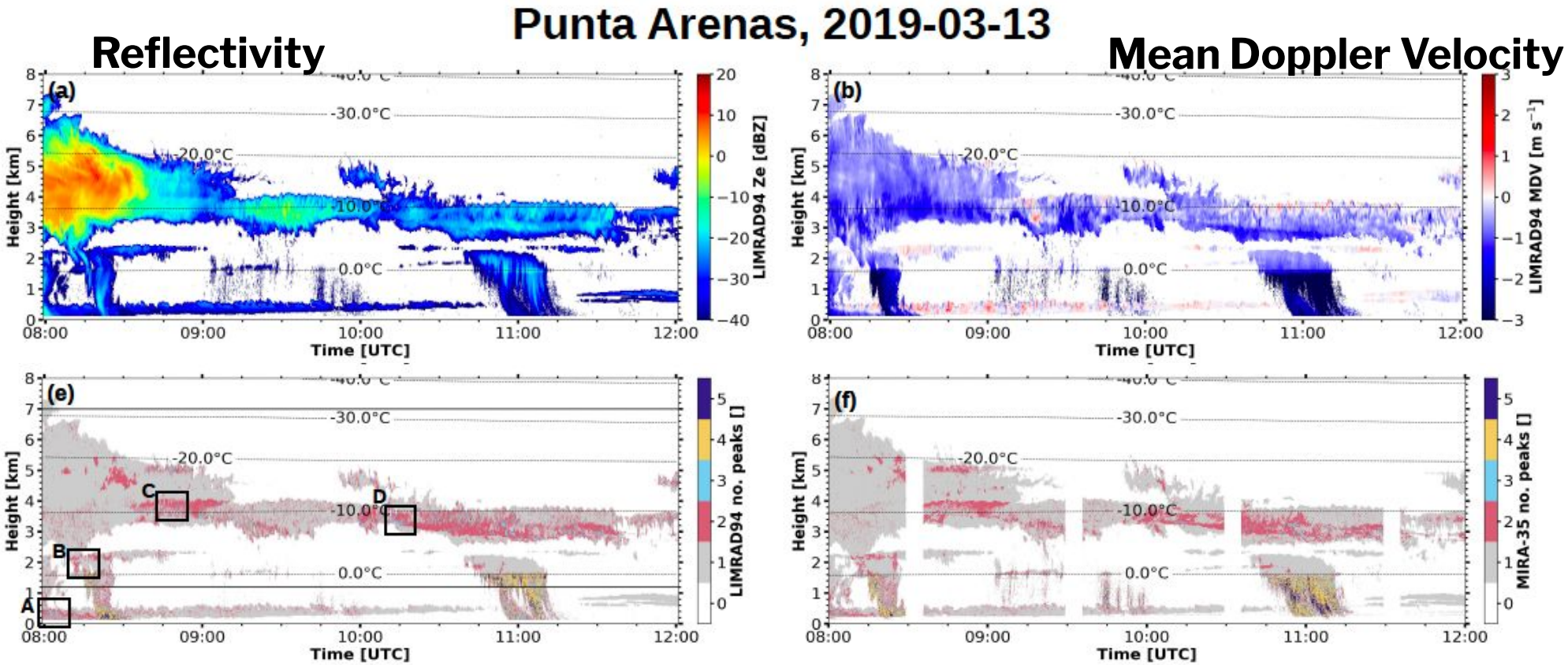
Example: detection of liquid cloud layers



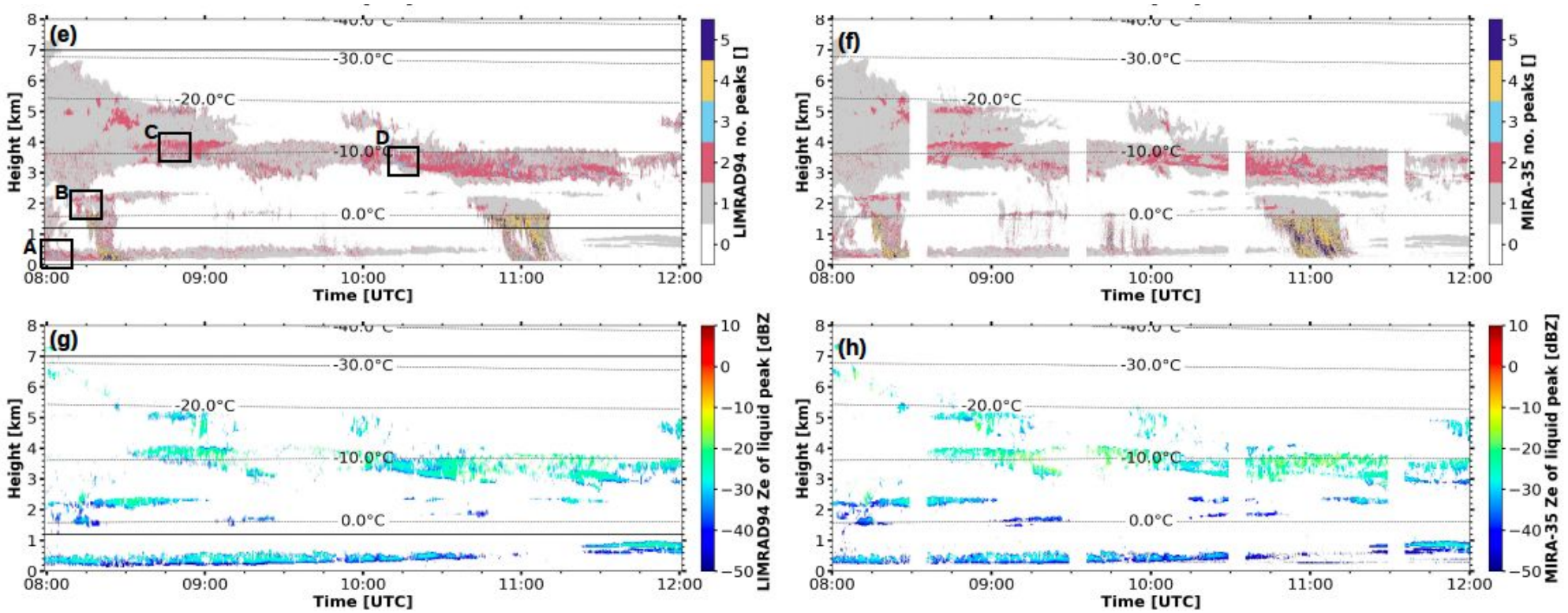
Number of peaks LIMRAD94

Number of peaks MIRA35

liquid selection rule: Ze < -20dBZ and |MDV| < 0.3 m/s

Example: detection of liquid cloud layers

peaks can be attributed to liquid cloud droplets



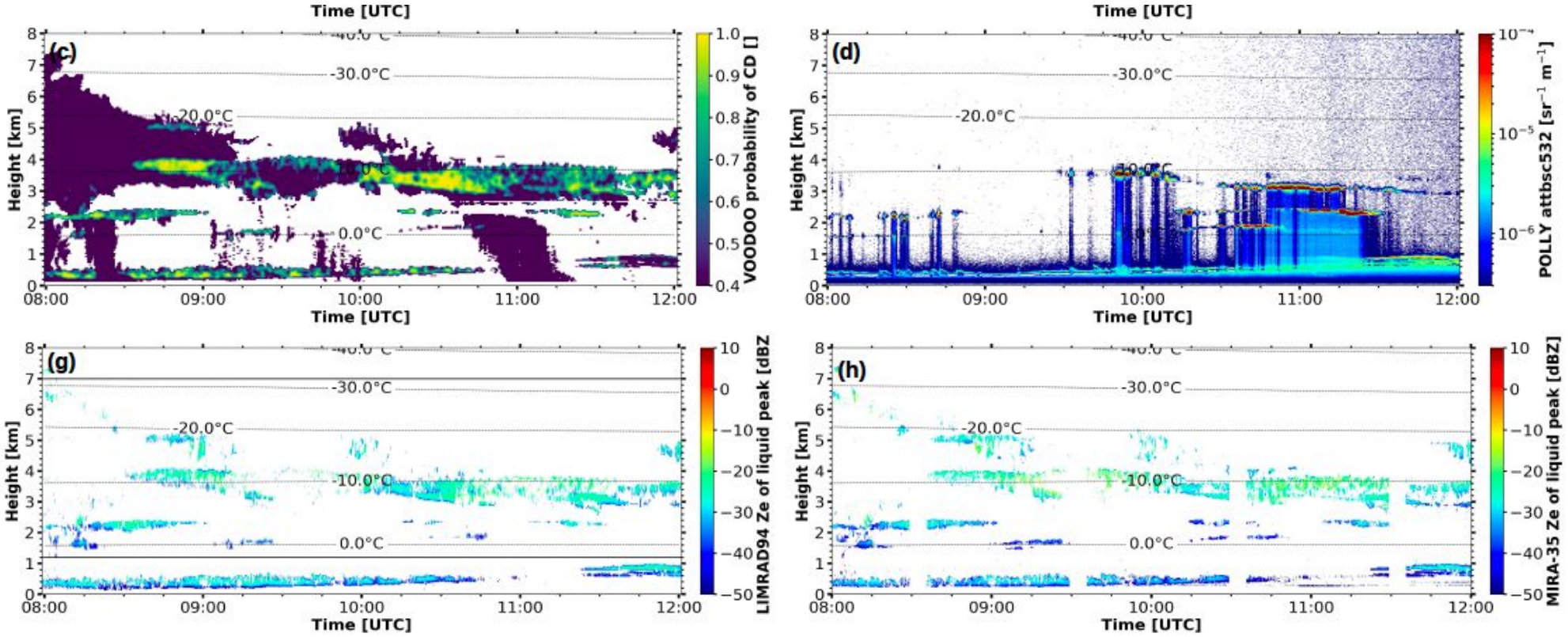
Liquid peak reflectivity LIMRAD94

Liquid peak reflectivity MIRA-35

liquid selection rule: Ze < -20dBZ and |MDV| < 0.3 m/s

Example: detection of liquid cloud layers

comparison to liquid-predicting convolutional neural network “VOODOO” and lidar backscatter



liquid selection rule: Ze < -20dBZ and |MDV| < 0.3 m/s

Conclusions & Outlook

- PEAKO and peakTree: two **open-source** Python-based tools
- Combination of the two algorithms & validation described in Vogl and Radenz et al. (2024, in discussion for AMT)
- **adjustable** to different cloud radar systems & settings
- **fast** processing of data sets possible

Outlook

- integration of PEAKO and peakTree into Cloudnet?
- Development of automated retrievals e.g. using liquid peak as air motion tracer, drop size distributions, riming flag, …

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Thank you