Two different approaches to derive wind gusts from Doppler wind lidar

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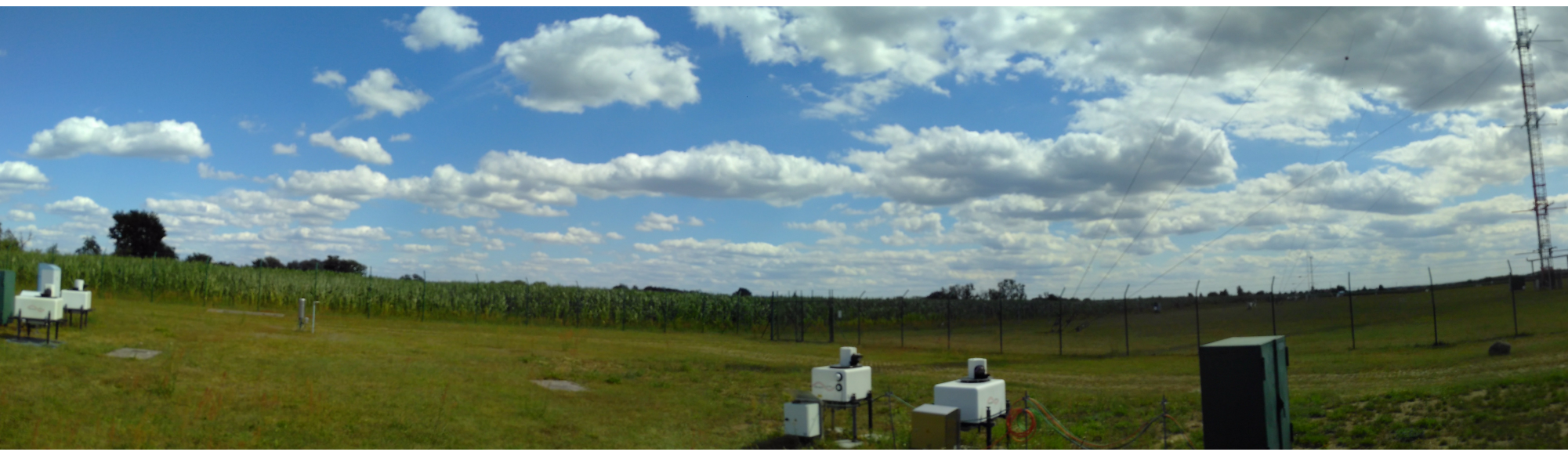


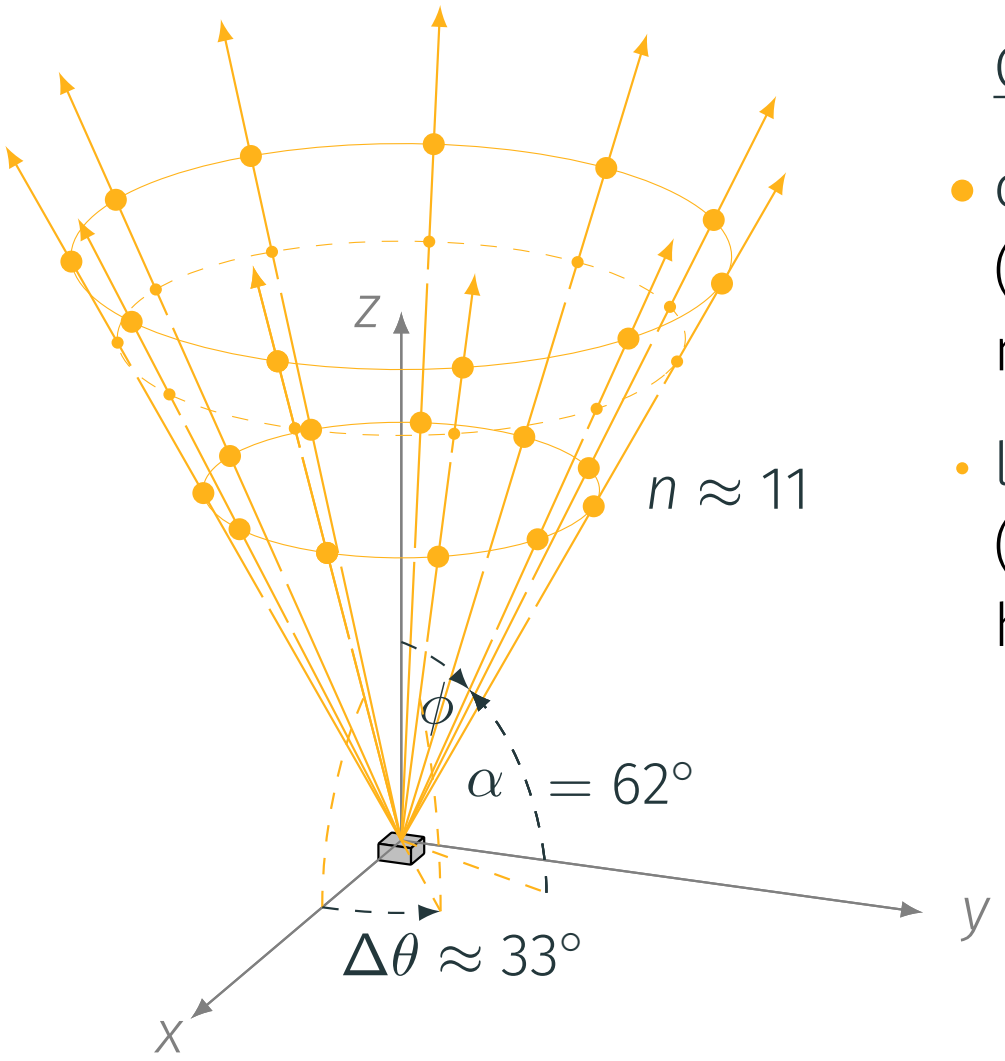
FESSTVaL Data Workshop Offenbach, May 18 – May 20, 2022

TOC: Wind gust from Doppler wind lidars (DWLs)

Continuous scanning mode

The 'gust mode'

quick continuous conical scanning mode (CSM) with 3000 pulses/beam

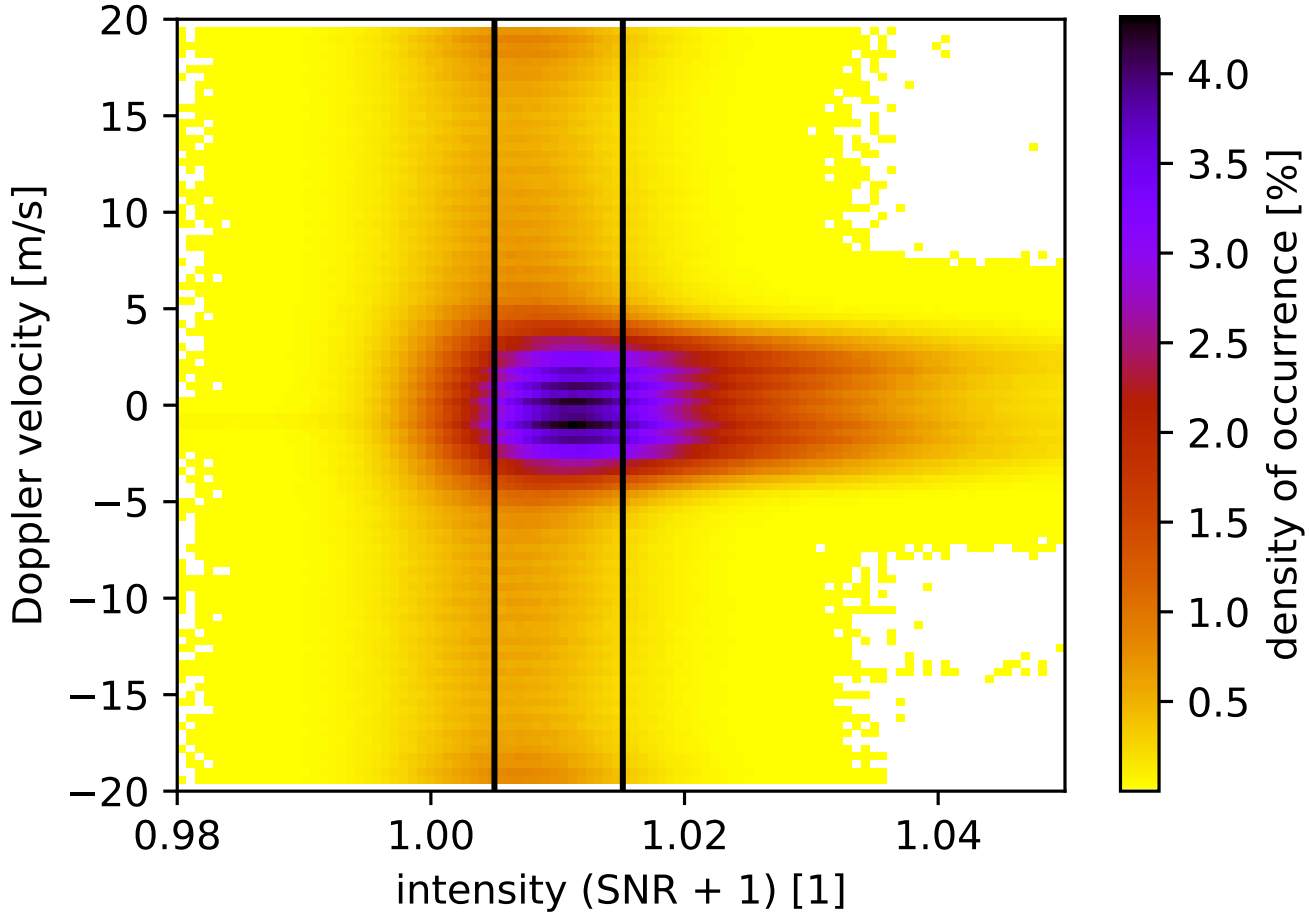


CSM in 3.4 s

- center of range gates (allocation of the) measurements)
- linear interpolation (e.g. for reference height at 90.3 m)

α elevation angle
ϕ zenith angle
θ azimuth angle

Noise filtering by threshold inappropriate



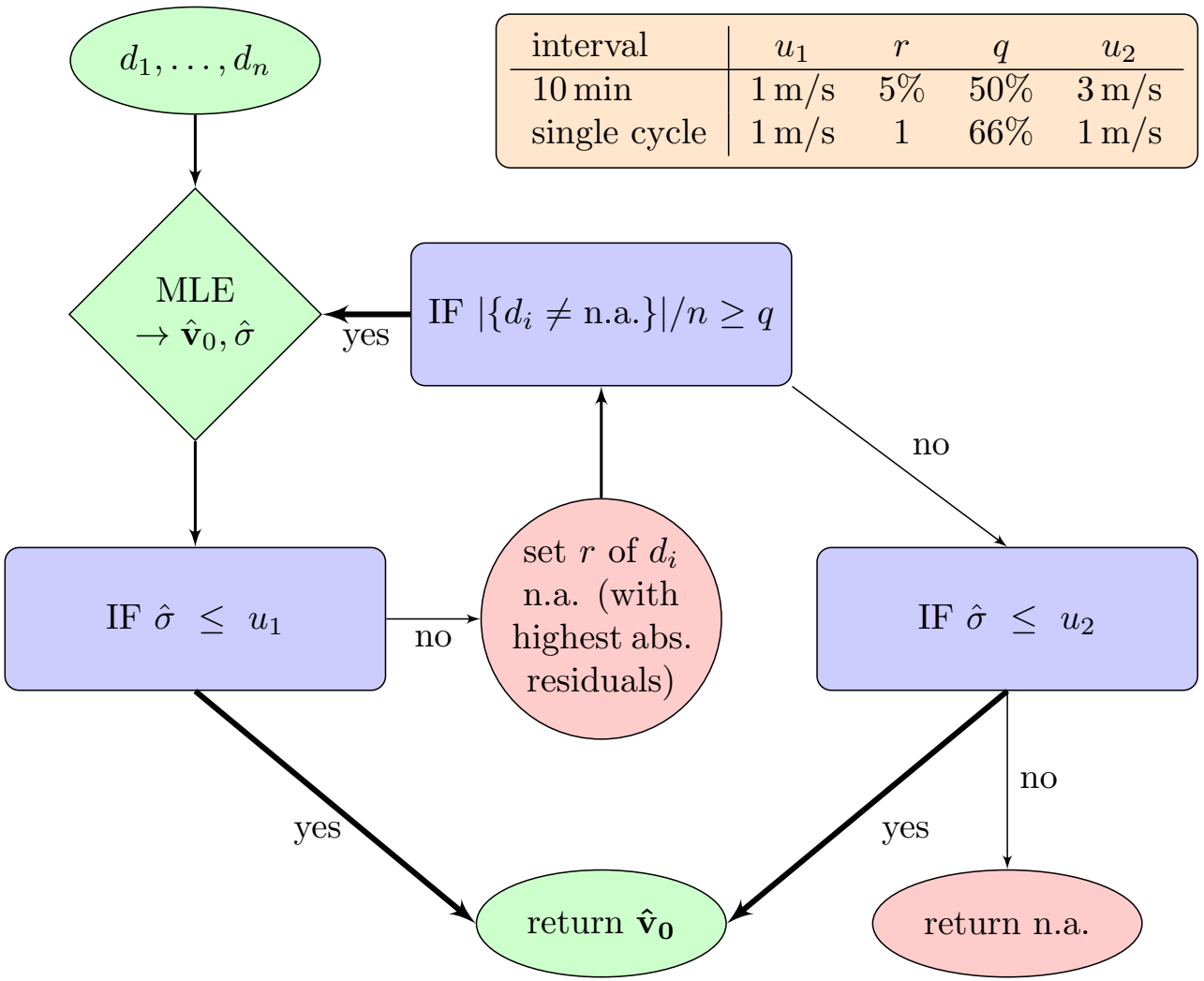
Left vertical line corresponds to an SNR value of −23 dB, right to −18.2 dB. Doppler velocities from 02/09/19 (25 mil. points).

$\rightarrow$ a threshold would filter out too many Doppler velocities

Julians retrieval

Iterative maximum likelihood estimation (MLE)

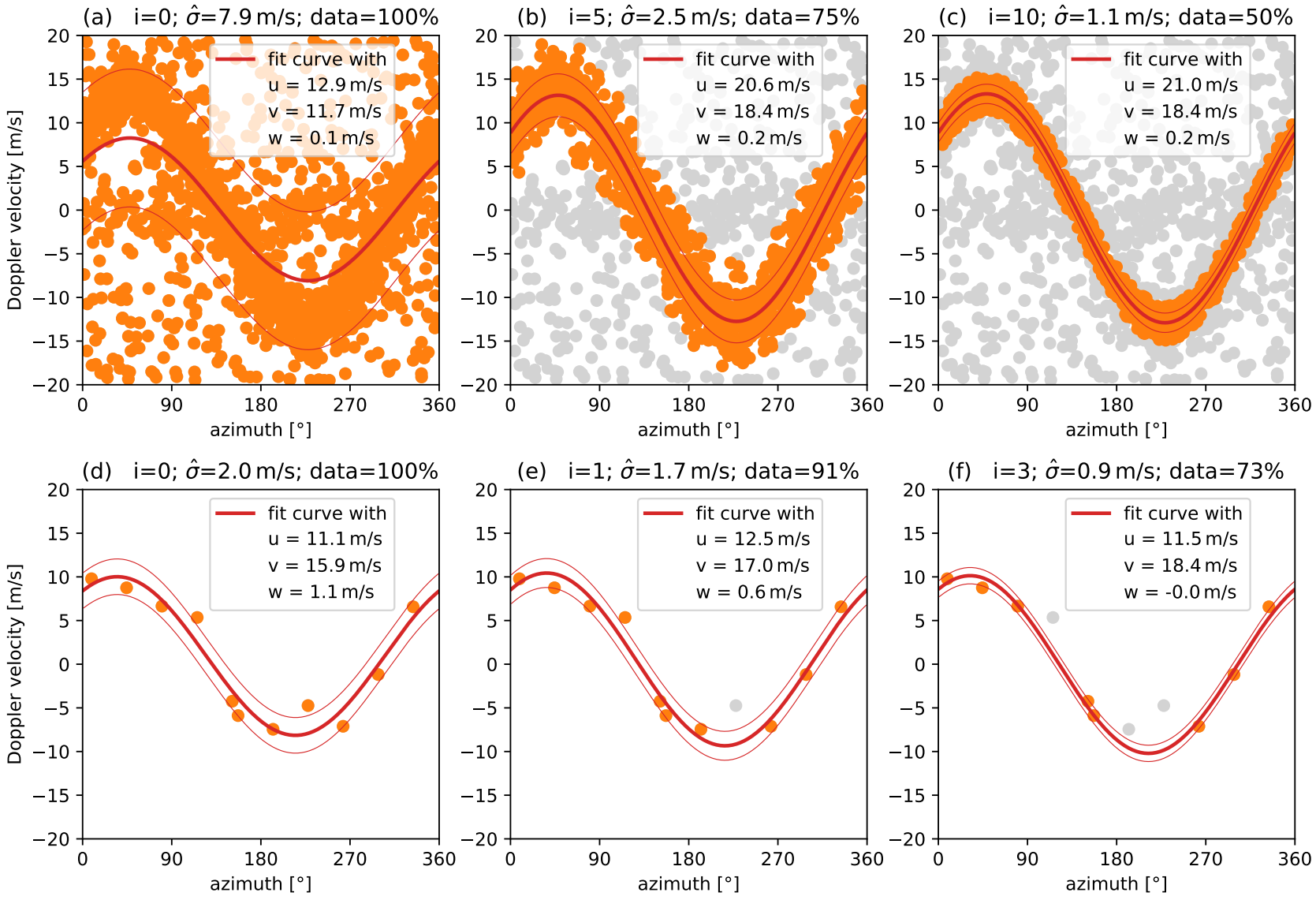
→ iteratively improve estimation by neglecting bad-fitting data



interval	u_1	r	q	u_2
10 min	1 m/s	5%	50%	3 m/s
single cycle	1 m/s	1	66%	1 m/s

see Steinheuer et al. 2022

Iterative retrieval for requested time interval



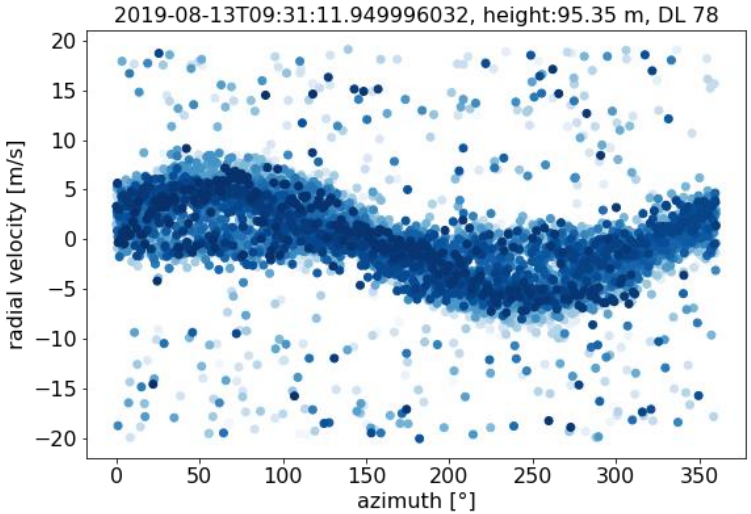
→ find a matching solution for a sufficient amount of data

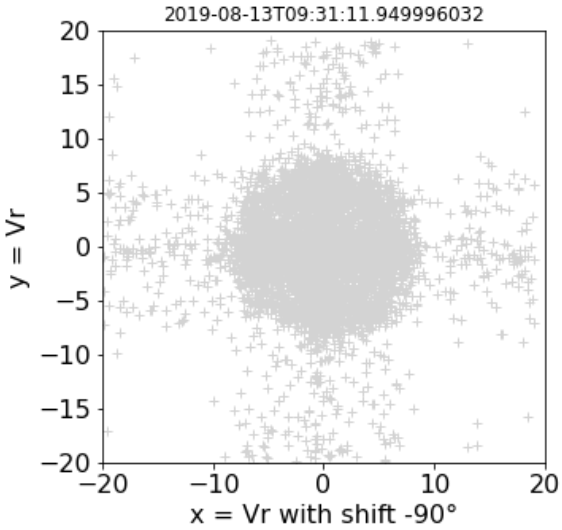
Carolas retrieval

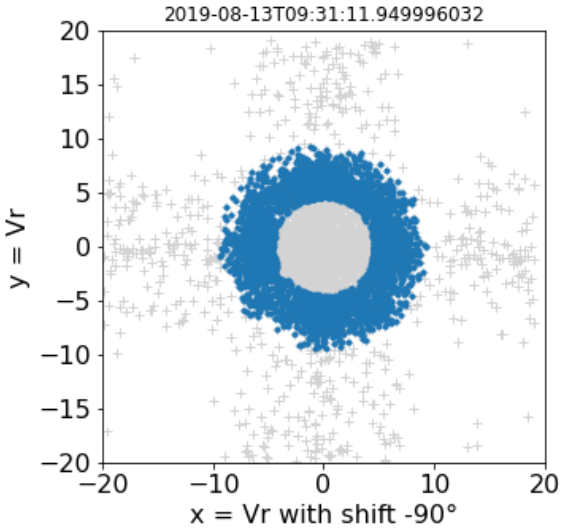
Noise filtering with focus on removing zero noise

→ project the *radial velocities(azimuth)= y* against *radial velocities(azimuth-90°)= x*

→ a sine curve becomes a cycle

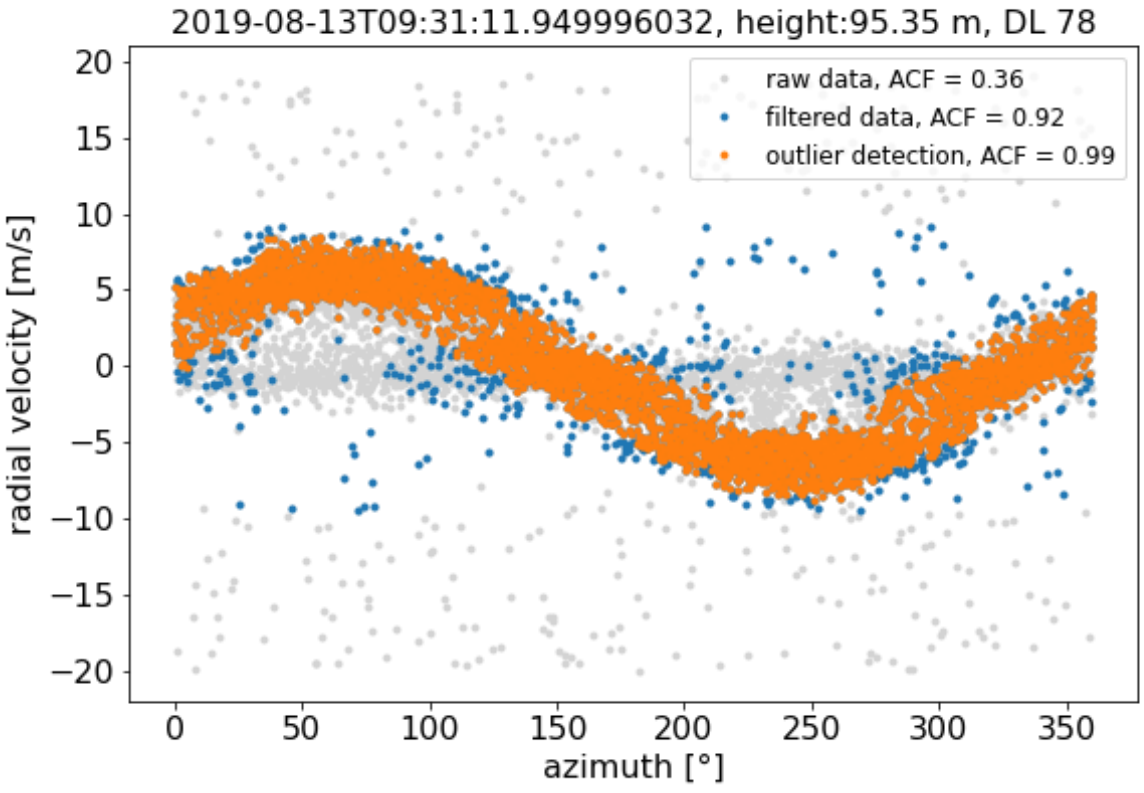






→ Use the auto correlation function (ACF) to identify radii bands around (0,0) without noise and discards the rest of the data.

Detect and filter outliers that deviate too much from mean



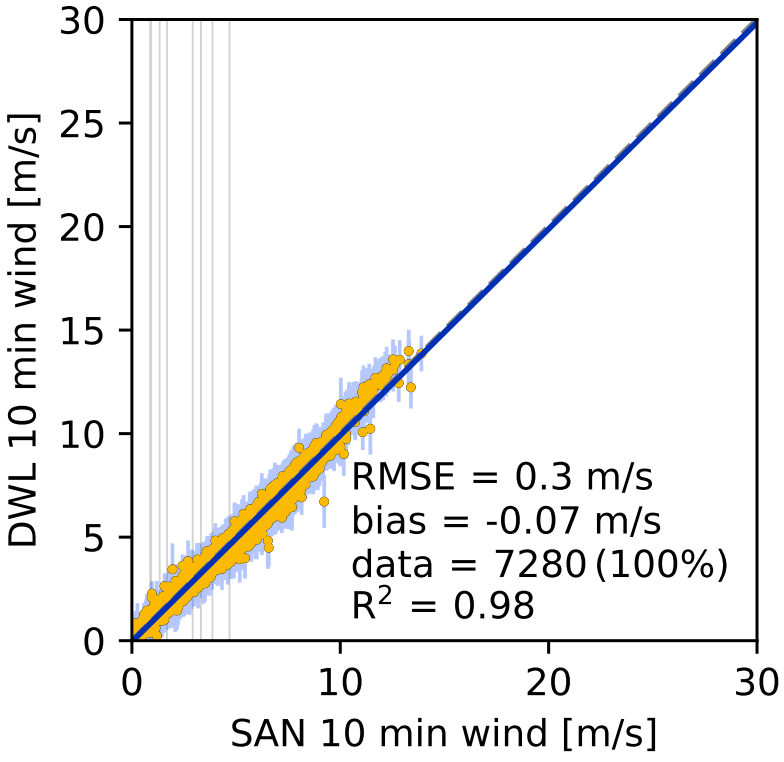
→ any point that is $n \times$ *standard deviation* away from mean is filtered out

→ orange observations are the basis for the calculation of both the mean wind and gusts

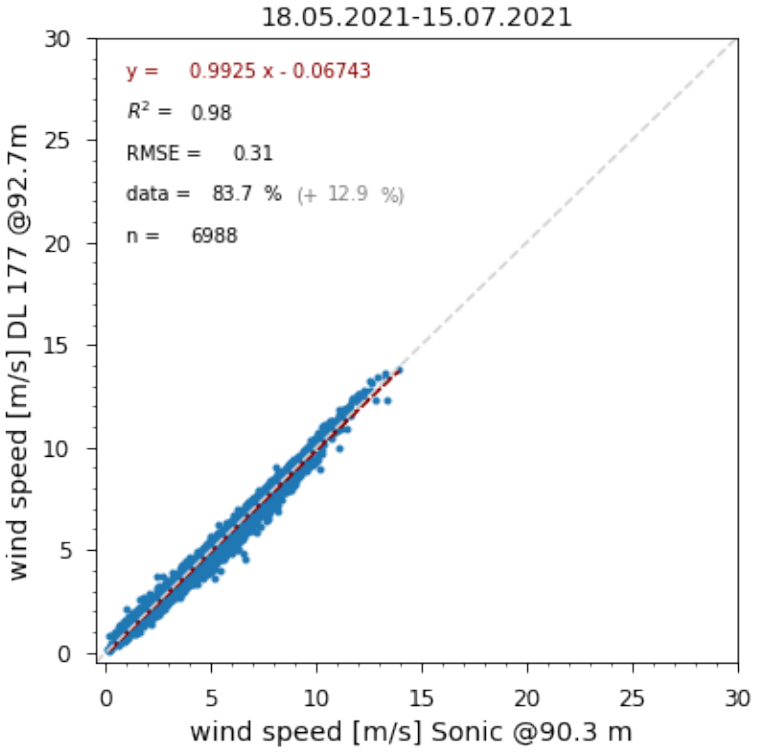
First comparison

18.5-15.7: Mean wind: sonic anemometer (90.3 m) vs. DWL 177

↓ Julians retrieval
(DWL at 90.3 m)

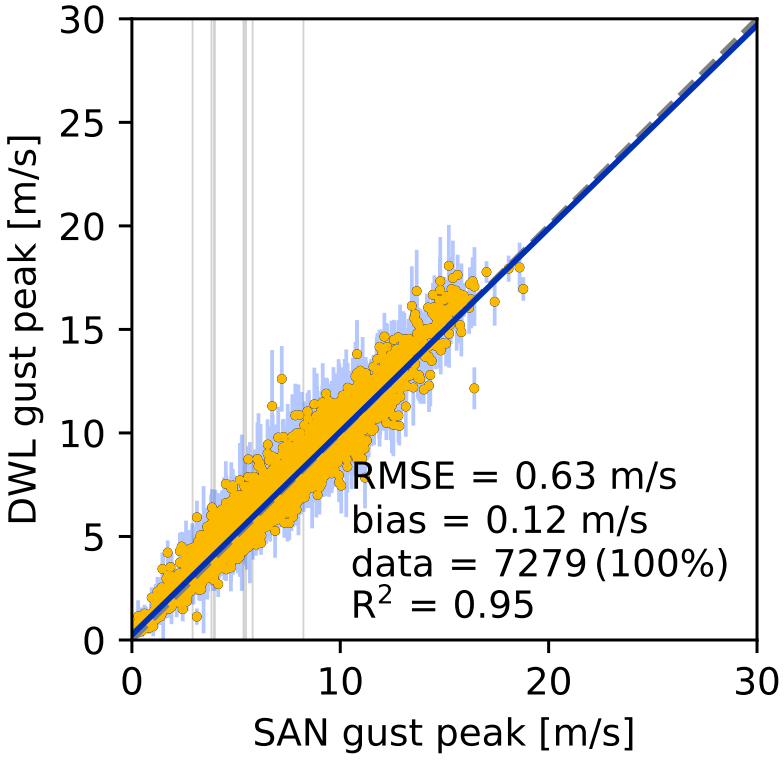


↓ Carolas retrieval
(DWL at 92.7 m)

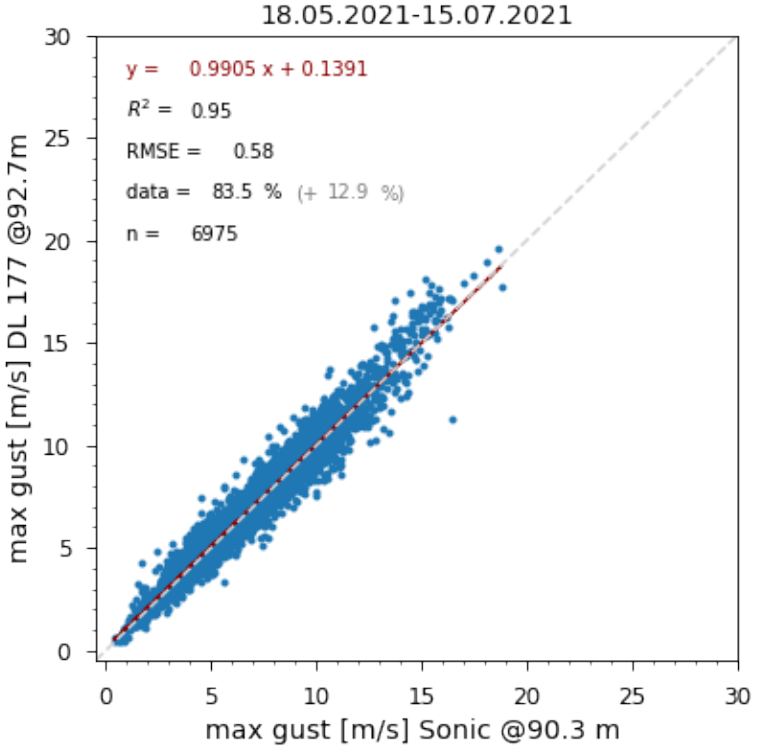


18.5-15.7: Wind gusts: sonic anemometer (90.3 m) vs. DWL 177

↓ Julians retrieval
(DWL at 90.3 m)



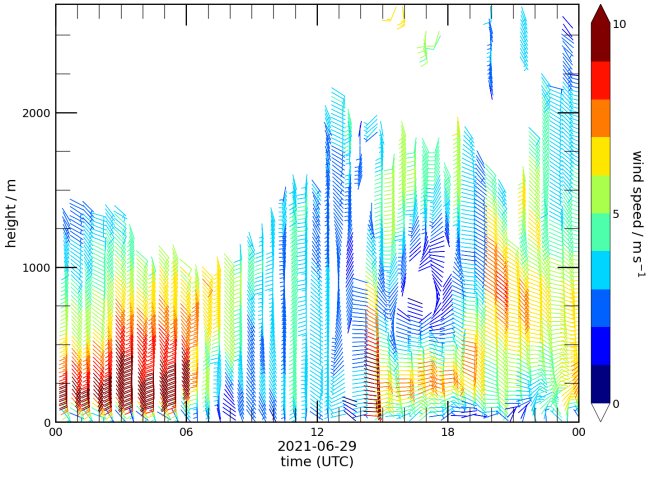
↓ Carolas retrieval
(DWL at 92.7 m)



→ similar performing retrievals at 90 m

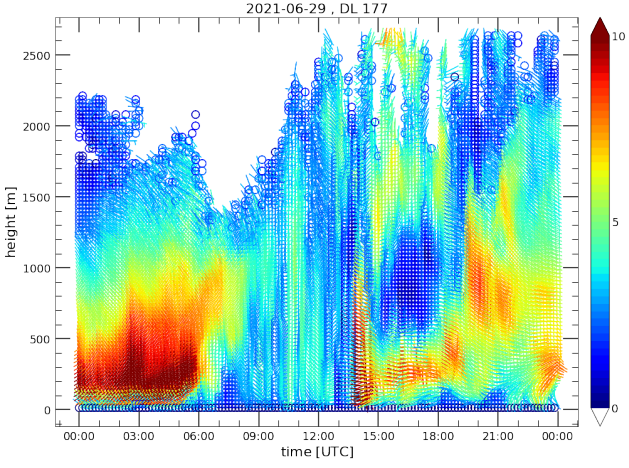
Quicklooks for mean wind on June 29, 2021 (Jogi)

↓ Markus retrieval



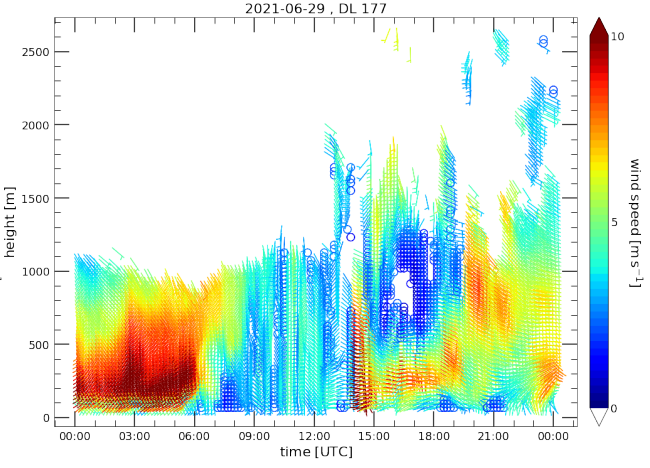
→ no azimuth correction

↓ Julians retrieval



→ higher vertical resol. with more zero wind

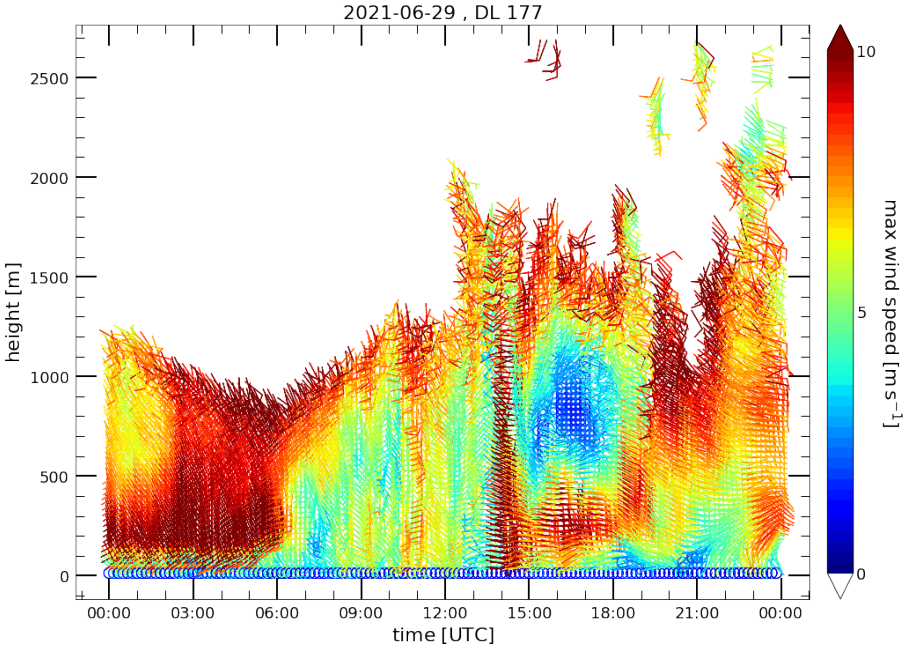
↓ Carolas retrieval



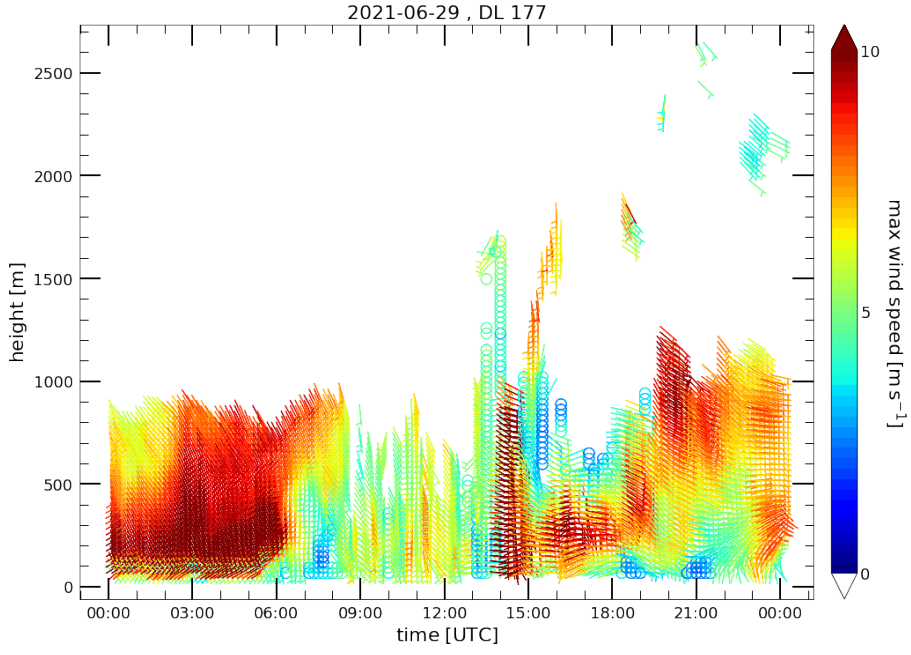
→ less zero wind

Quicklooks for wind gusts on June 29, 2021 (Jogi)

↓ Julians retrieval



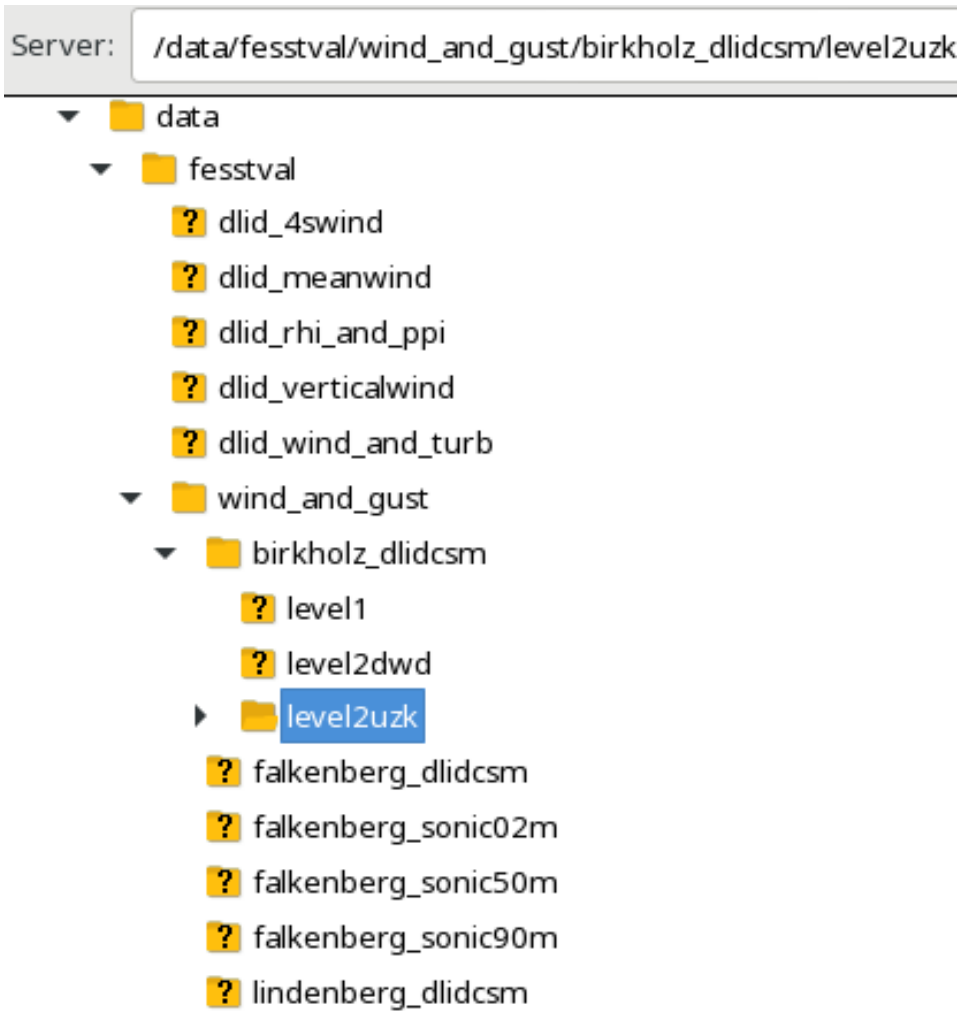
↓ Carolas retrieval



→ (left) has higher vertical resolution, but may have more erroneous winds in the boundary regions than (right)

! You see only one example !

ftp uploads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dlid_meanwind
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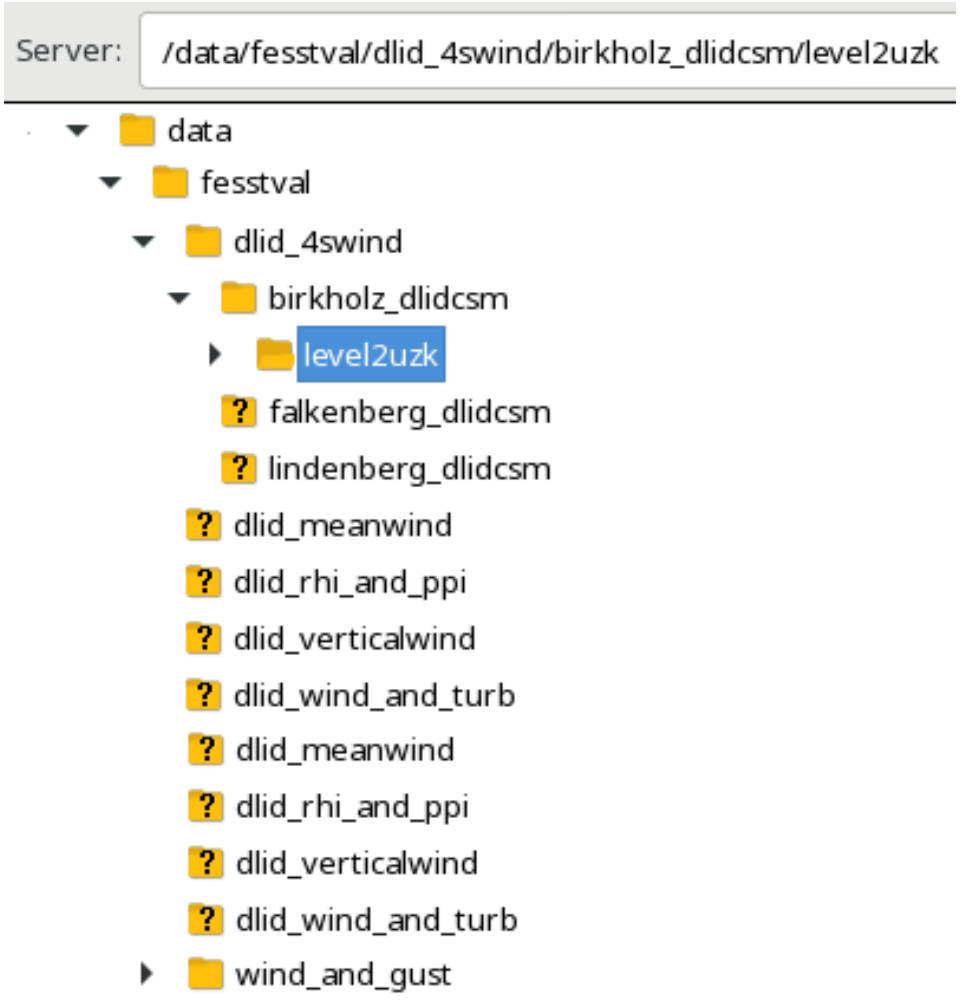
dlid_verticalwind
dlid_wind_and_turb
wind_and_gust
birkholz_dlidcsm
level1
level2dwd
level2uzk
falkenberg_dlidcsm
falkenberg_sonic02m
falkenberg_sonic50m
falkenberg_sonic90m
lindenberg_dlidcsm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level2uzk
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lindenberg_dlidcsm
dlid_meanwind
dlid_rhi_and_ppi
dlid_verticalwind
dlid_wind_and_turb
dlid_meanwind
dlid_rhi_and_ppi
dlid_verticalwind
dlid_wind_and_turb
wind_and_gust

Conclusion and prospect

Conclusion and prospect

→ Quick CSM can measure wind gust peaks

! and high-resolution wind patterns (triangle, tomorrow)

→ Proved at 90.3 m for both retrievals

? Comparisons in higher levels (DWD, HH)

? Comparisons with UAV flights (TÜB)

→ Especially noise around zero is challenging

! Paper in progress (Päschke, Detring)

… The retrievals can be always improved …

Steinheuer, Julian et al. (Jan. 2022). "A new scanning scheme and flexible retrieval for mean winds and gusts from Doppler lidar measurements". In: DOI: *10.5194/amt-2021-426*. URL: *https://doi.org/10.5194/amt-2021-426*.

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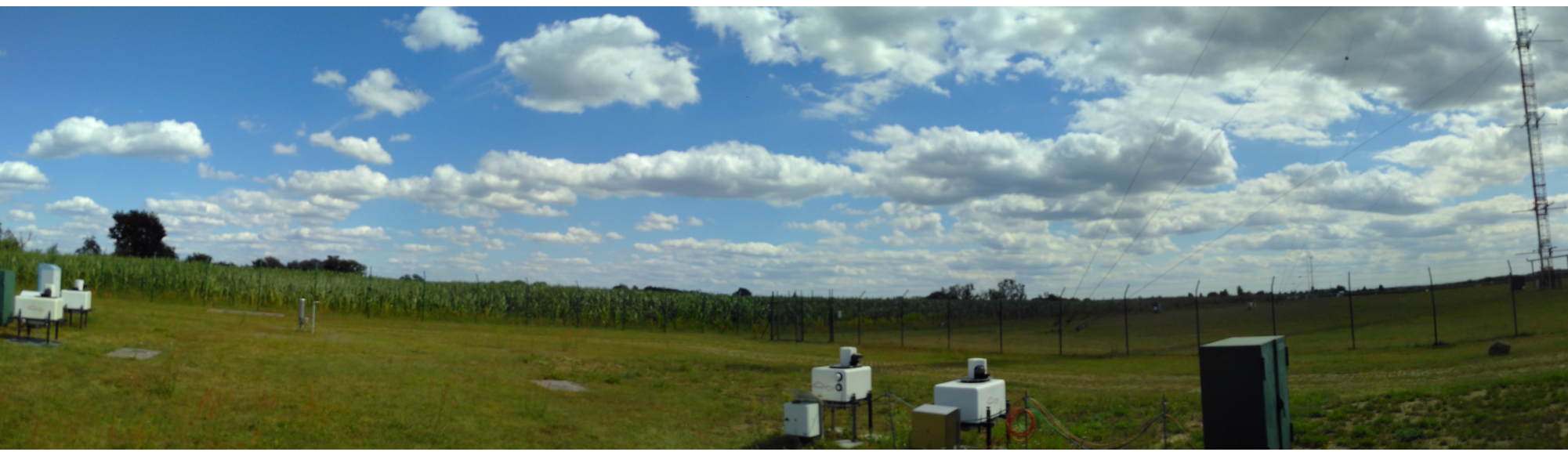

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