High-resolution vertical profiling from the three supersites

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

Objective

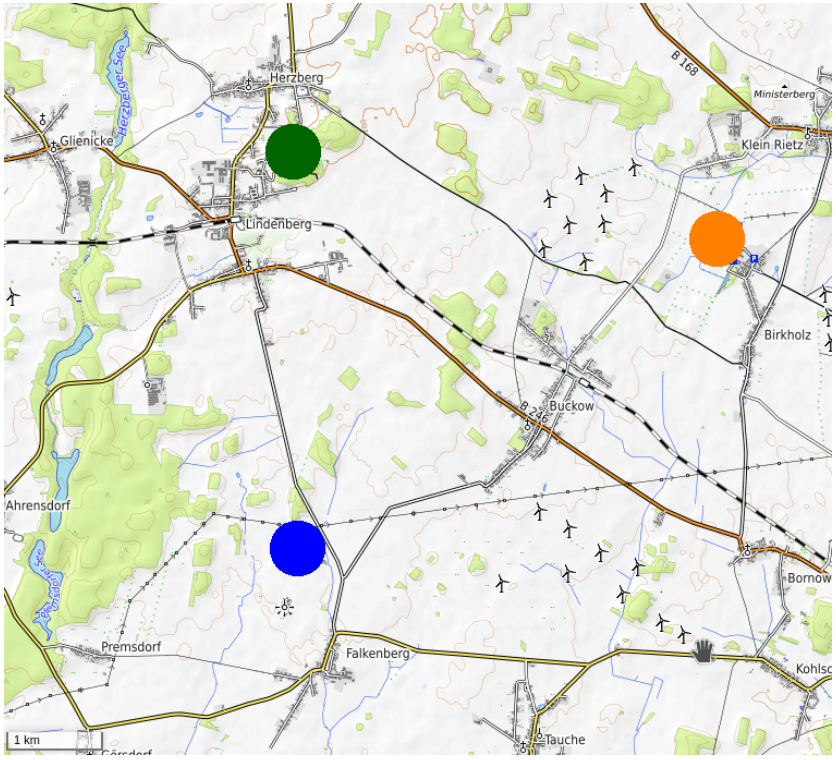

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Figure 1: Locations of the three supersites 6 km apart from each other: Lindenberg (L), Birkholz (B), and Falkenberg (F).

- generate high-resolution wind profiles in the ABL
- use multiple lidars to detect sub-mesoscale variability in wind field
- investigate storms with multiple remote sensing devices

TOC: High-resolution vertical profiling

1. How meaningful is a wind observation for surrounding area?
2. Is the DWL w-component useful?
3. MWR measurements
4. Cold front passage (June 12, 2021)
5. Cold pool Jogi (June 29, 2021)
6. Conclusion

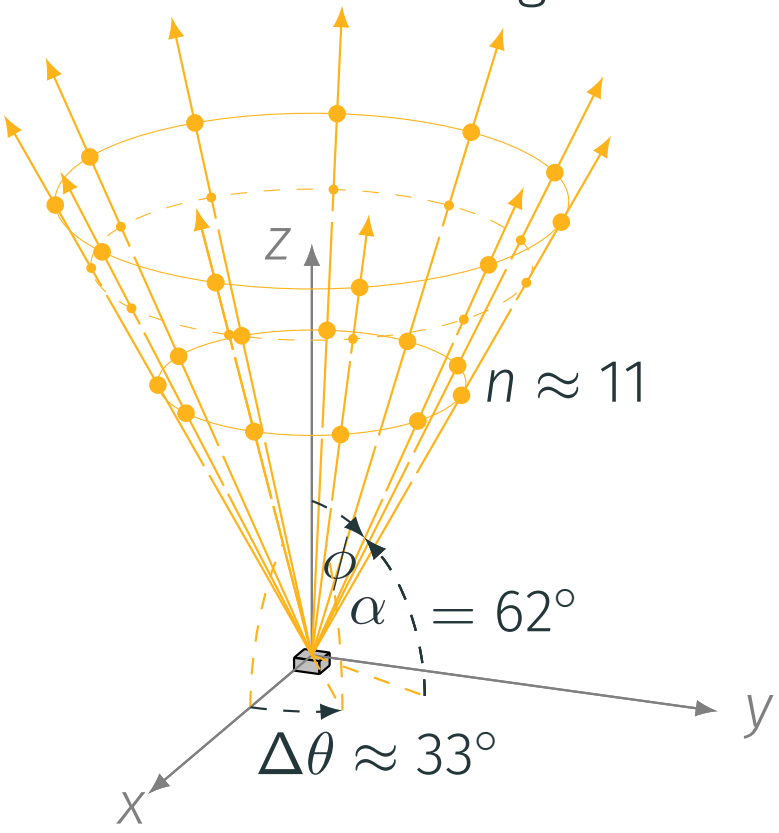
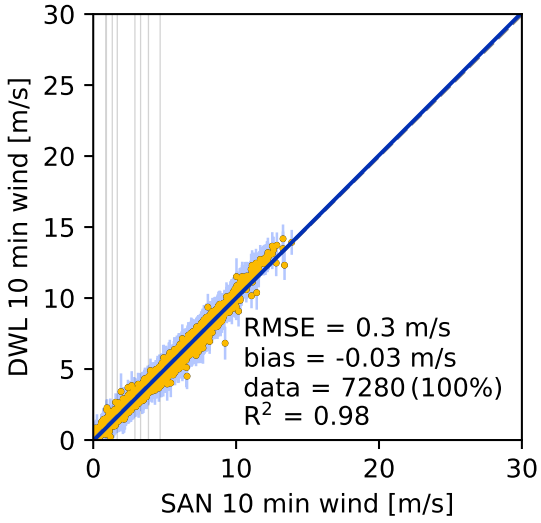


Figure 2: Observation principle of CSM with 11 measurements in 3.4 s and 3000 pulses/beam. See Steinheuer et al. 2022 for the gust retrieval.

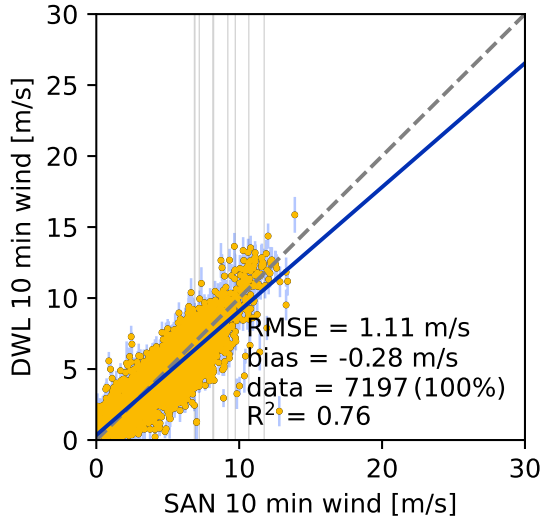
How meaningful is a wind observation for surrounding area?

How representative is a mean wind measurement from 90.3 m in Falkenberg for the domain (i.e. for Birkholz and Lindenberg)?

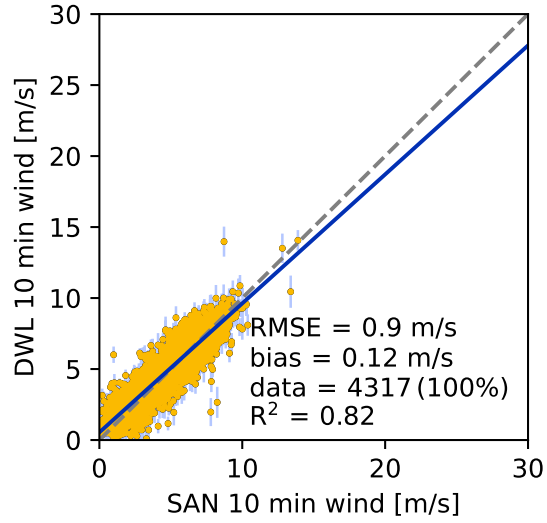
↓ Falkenberg DWL 18.5-31.8



↓ Birkholz DWL 11.6-31.8



↓ Lindenberg DWL 18.5-31.8

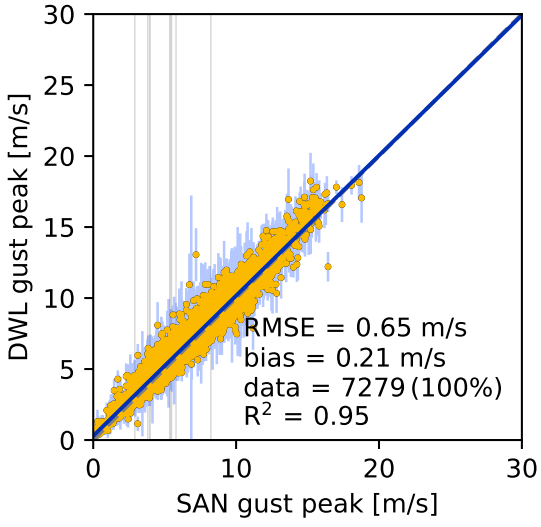


all vs. Falkenberg sonic anemometer at 90.3 m

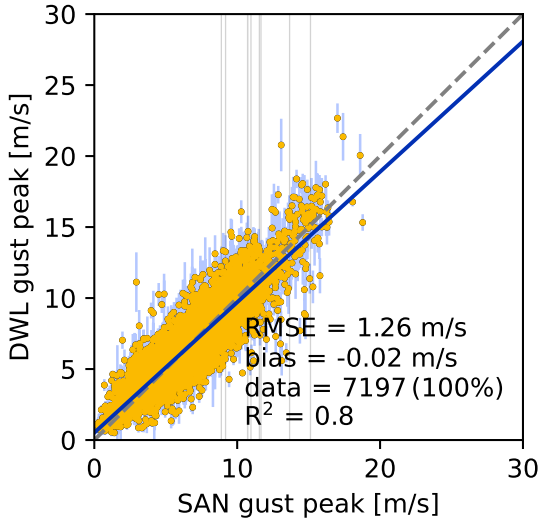
→ scatterplots for sonic vs. 6 km apart locations shows significant increase in variability

How representative is a wind gust measurement from 90.3 m in Falkenberg for the domain (i.e. for Birkholz and Lindenberg)?

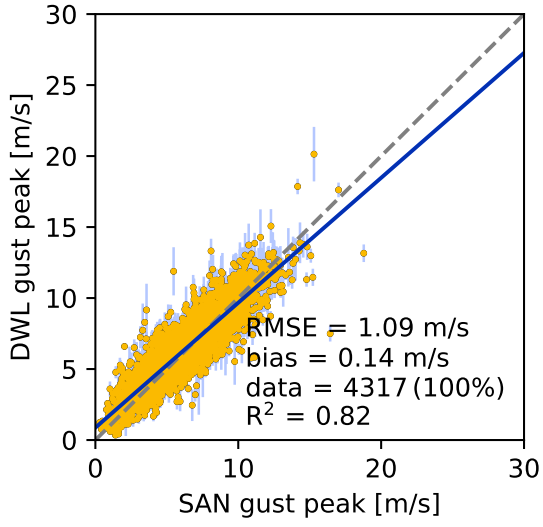
↓ Falkenberg DWL 18.5-31.8



↓ Birkholz DWL 11.6-31.8



↓ Lindenberg DWL 18.5-31.8



all vs. Falkenberg sonic anemometer at 90.3 m

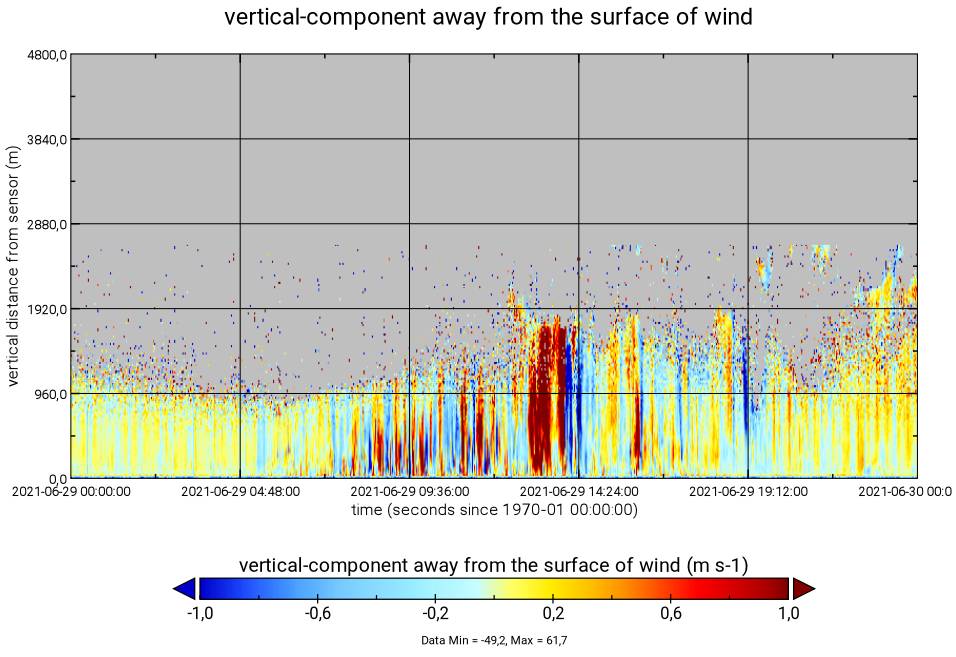
→ increase in variability in the order of mean wind

→ some higher gusts were observed in B and L

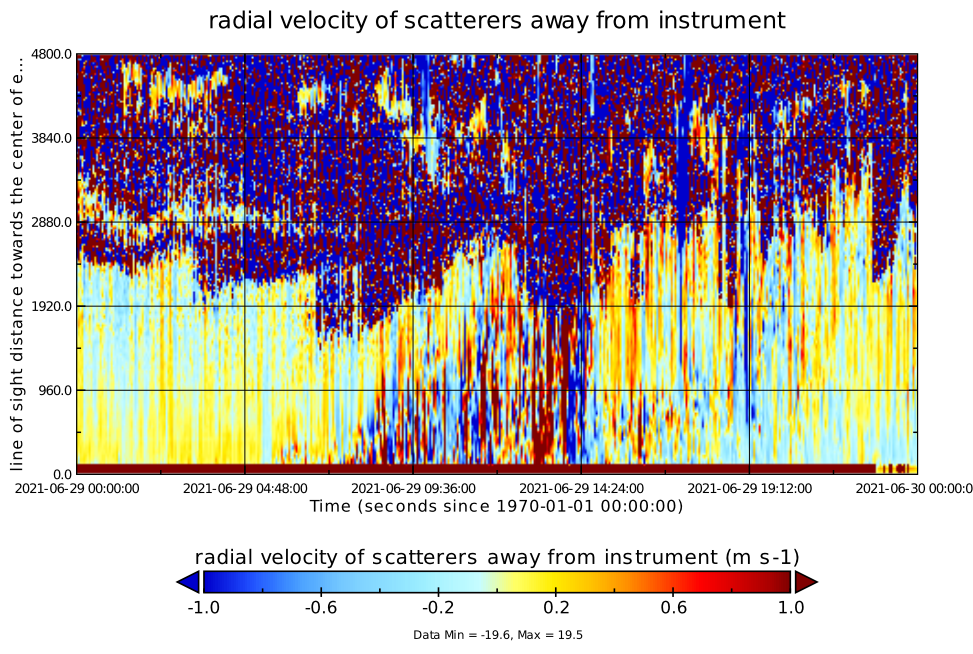
Is the DWL w-component useful?

DWL w-component for example day (June 29, Falkenberg)

↓ DWL in gust mode



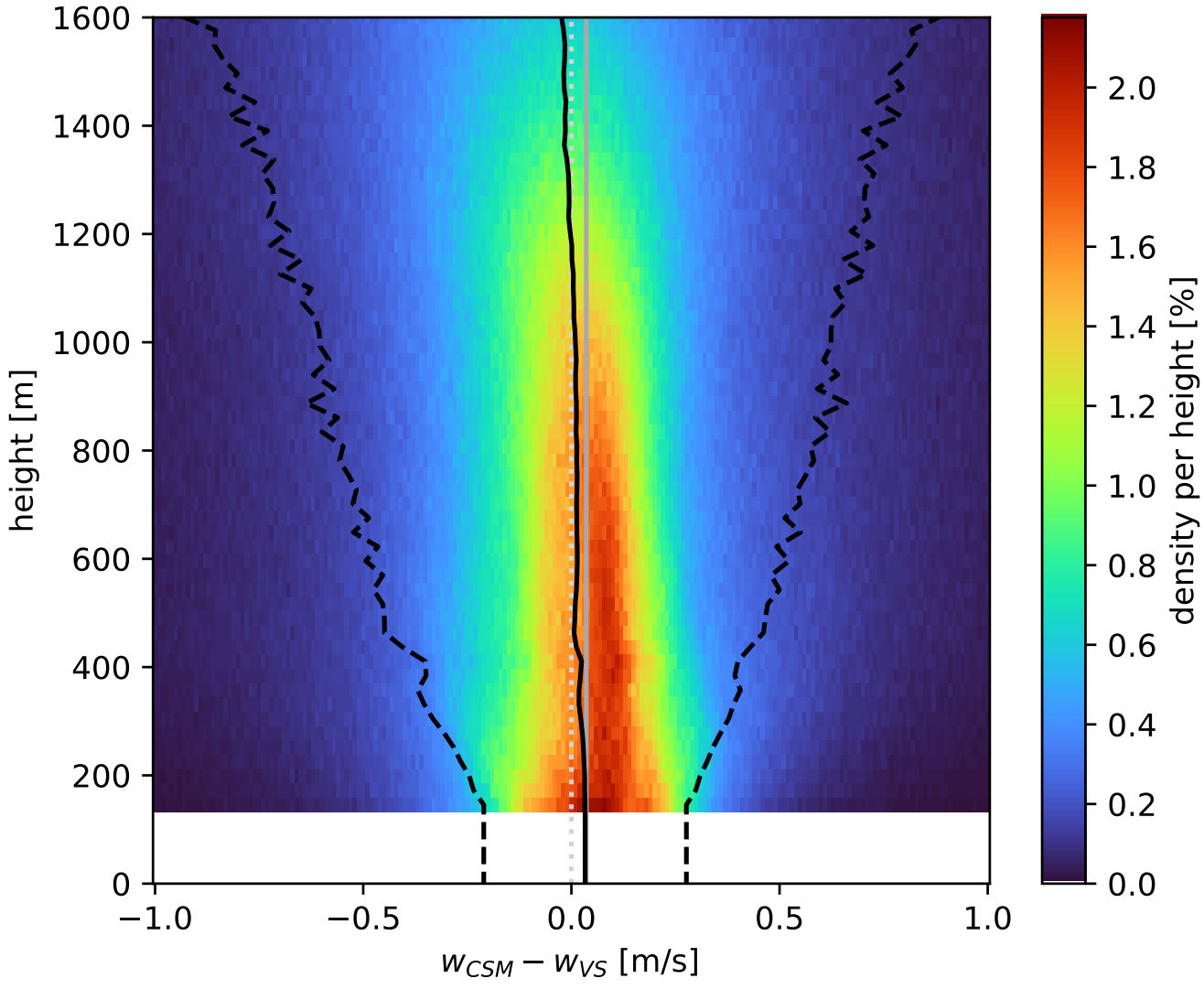
↓ DWL vertical staring



both in 1 minute resolution

→ similar structures

w-statistics over 2 months summer 2021 (minute resolution)



→ has potential, but needs more investigation

MWR measurements

MWR instrument setup

Univ. Cologne system (1)
Continuous azimuth scans @ 30° elevation

Lindenberg RAOHAT

Lindenberg FOGHAT

DWD & HH system
"Standard" mode: vertical stare & elevation scans every 15min

Birkholz HAMHAT

Univ. Cologne system (2)
Continuous elevation scans

Falkenberg SUNHAT

~ 4km

Motivation

- Best continous ($\sim$ min) estimate of **cloudy vertical ABL thermodynamic structure** during FESSTVaL
  $\rightarrow$ complement to radiosondes

- **Sub-meso-scale variability** of vertical temperature and humidity structure

- How are the horizontal **humidity and temperature inhomogeneities** during:
  - ABL build-up?
  - Frontal passage?
  - Cold-pools?

Data uploaded to ICDC

May 12, 2022

Dataset | Open Access

Microwave Radiometer Observations during FESSTVaL 2022

Löhnert, Ulrich; Knist, Christine; Böck, Tobias; Pospichal, Bernhard

This data set contains level1 (brightness temperatures) and level2 (retrieved meteorological variables) of the four ground-based microwave radiometers (MWR) measuring during FESSTVaL 2022 (May-August) at Lindenberg (2 MWR, dwd and uzk), Falkenberg (1 MWR, uzk) and Birkholz (1 MWR, uhh).

For each MWR you find up to seven data file types.

1. Up to two level1 data file types: arbritrary viewing direction (e.g. *mwr00_l1_tb_*) and boundary layer scans (e.g. *mwrBL00_l1_tb_*)
2. Up to five level2 data file types: path integrated liquid water path (e.g. *_mwr00_l2_clwvi_*), path integrated water vapor (e.g. *_mwr00_l2_prw_*), coarse vertical resolution water vapor profiles (e.g. *_mwr00_l2_hua_*), coarse vertical resolution temperature profiles (*_mwr00_l2_ta_*), ABL temperature profiles (e.g. *_mwrBL00_l2_ta_*)

Publication date:
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DOI 10.25592/uhhfdm.10198

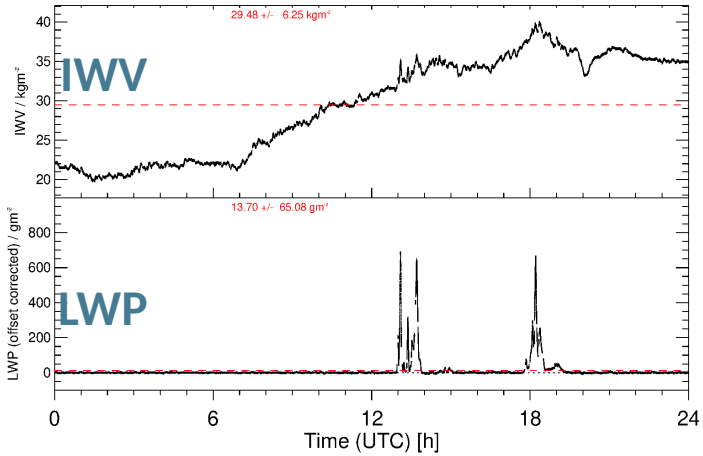
Keyword(s):
FESSTVaL | microwave radiometers | thermodynamic profiles | liquid water path | integrated water vapor | mwr_pro

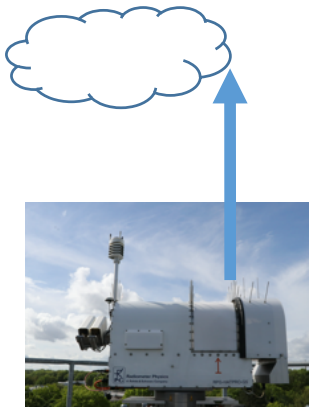
Communities:
Integrated Climate Data Center - ICDC

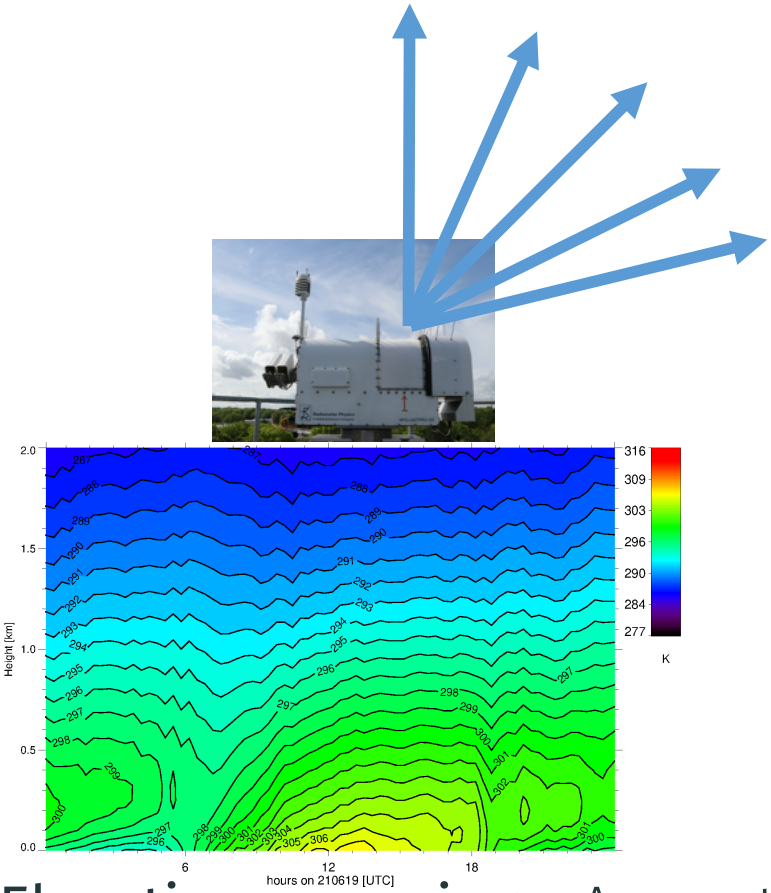
see Löhnert et al. 2022

Thanks to Annika Jahnke-Bornemann and ICDC!

Measurement modes & products







Vertical stare: Time series of LWP/IWV at Lindenberg & Birkholz every ∼2 s

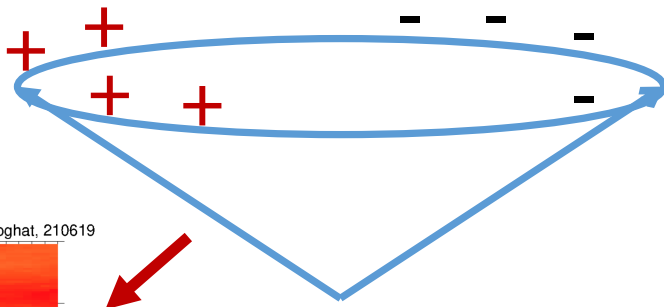
Elevation scanning: Accurate temperature profile up to 2 km at Falkenberg continuous, at Lindenberg & Birkholz every 15 min

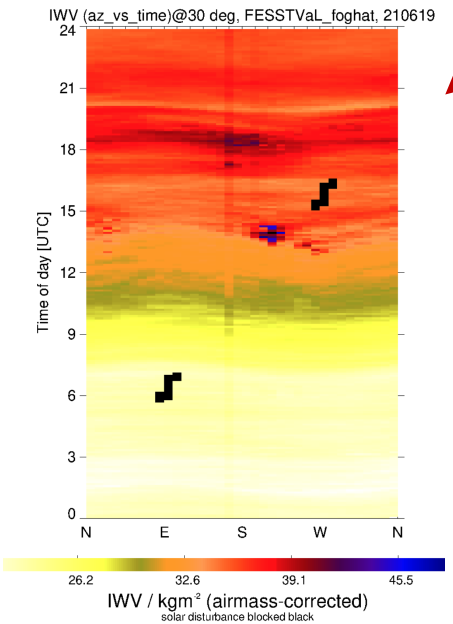
Measurement modes & products

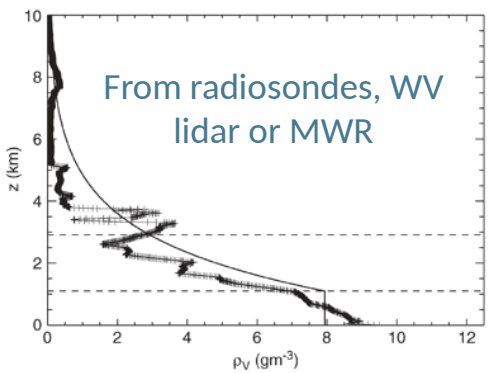
Azimuth scanning: Horizontal humidity gradient

- Continuous azimuth scans provide gradients every ~3 min
- Representative of ~10 km radius
- Need: path integrated WV and assumption on vertical humidity structure (Schween, Crewell, and Lohnert 2011)

at Lindenberg



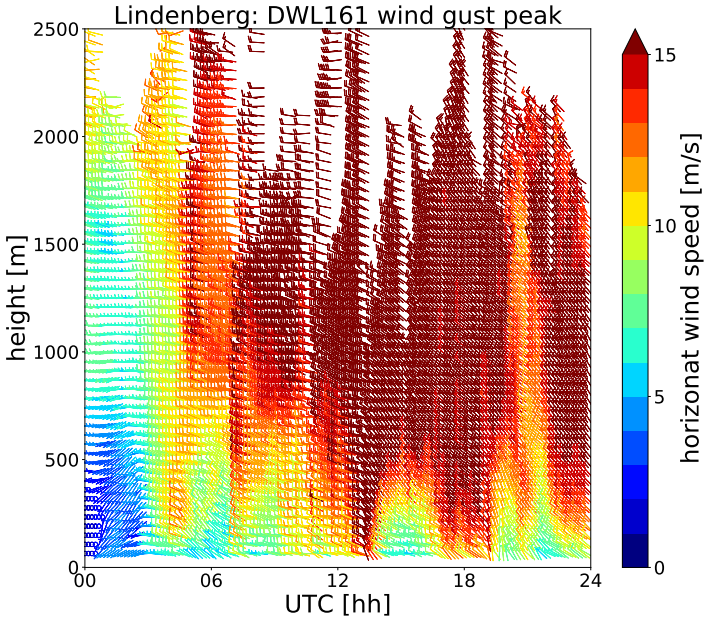


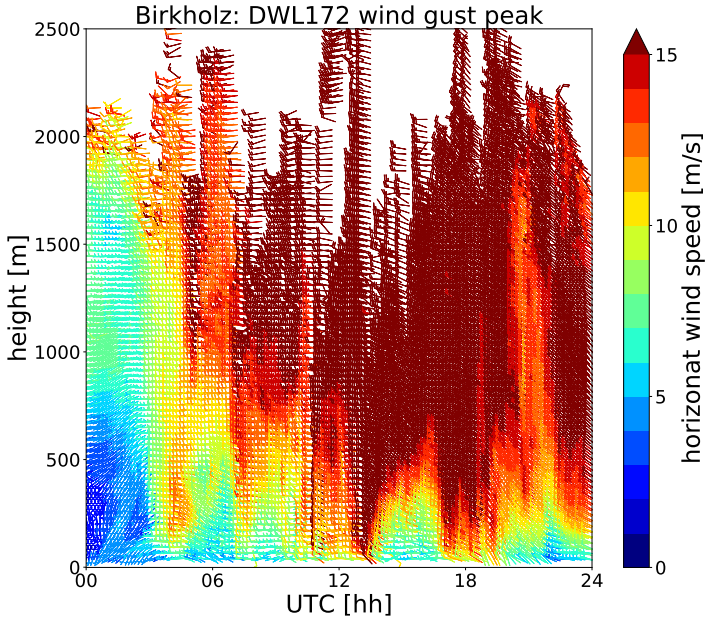


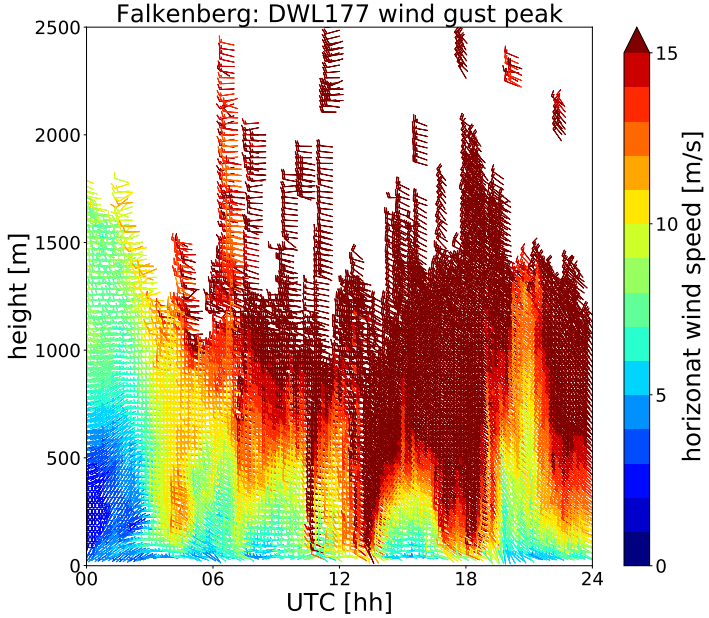
⇒ Area averaged **humidity gradient**

Cold front passage (June 12, 2021)

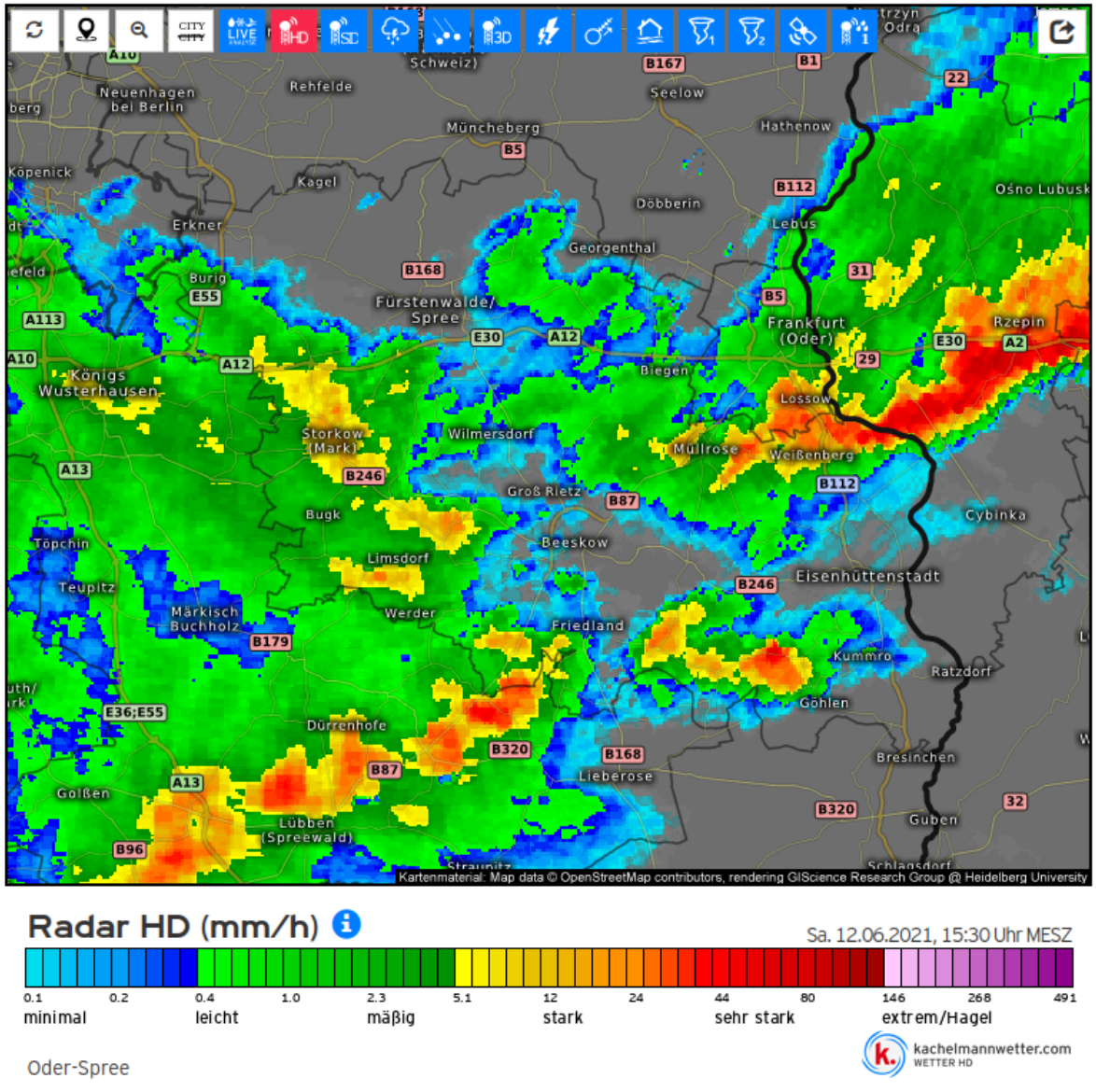
Triangle measuring cold front passage on 12.6.21 (day)





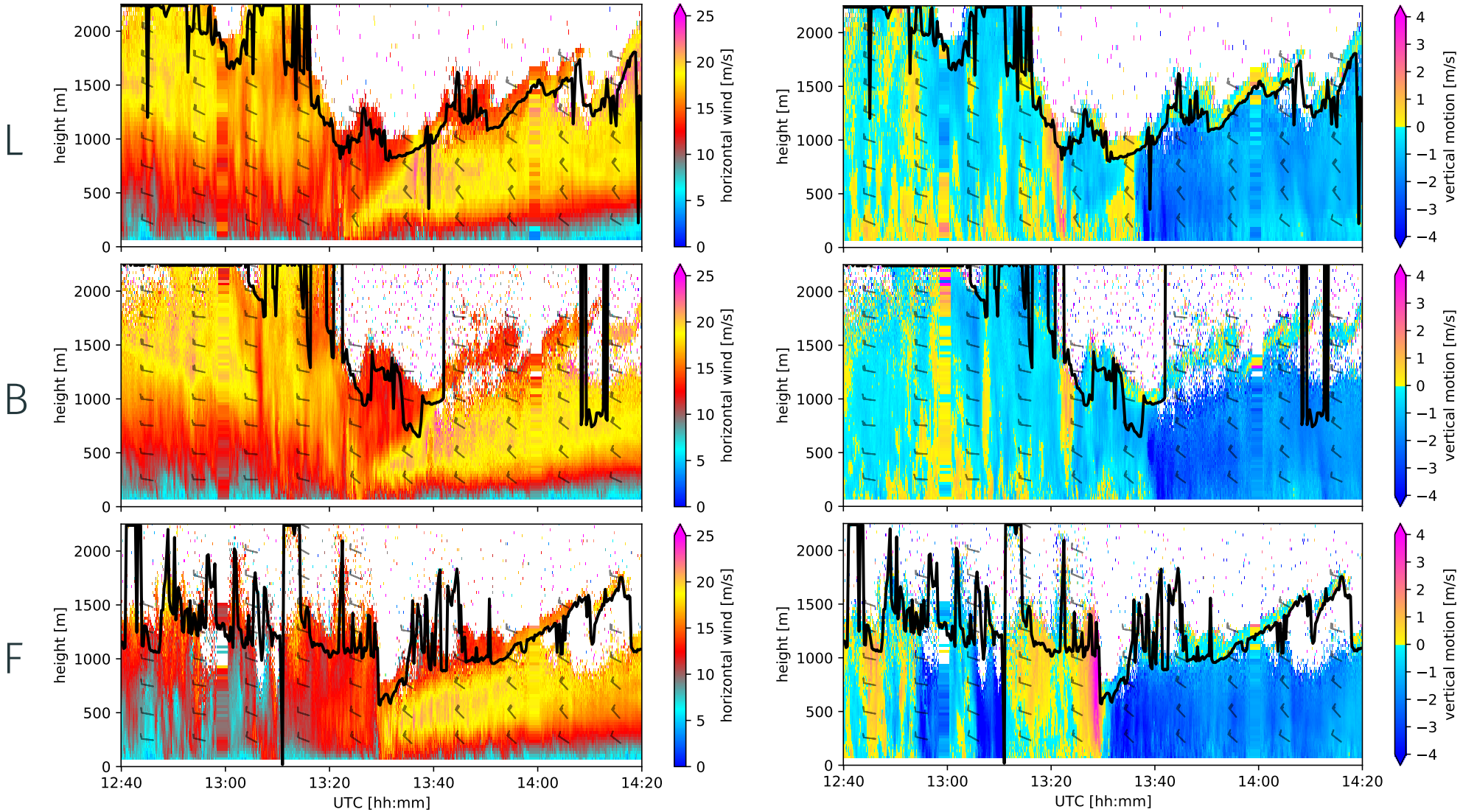


Triangle measuring cold front passage on 12.6.21 (13^{30})



kachelmannwetter.com/de/regenradar/oder-spree/20210612-1330z.html

Triangle measuring cold front passage on 12.6.21 (12^{40} – 14^{20})



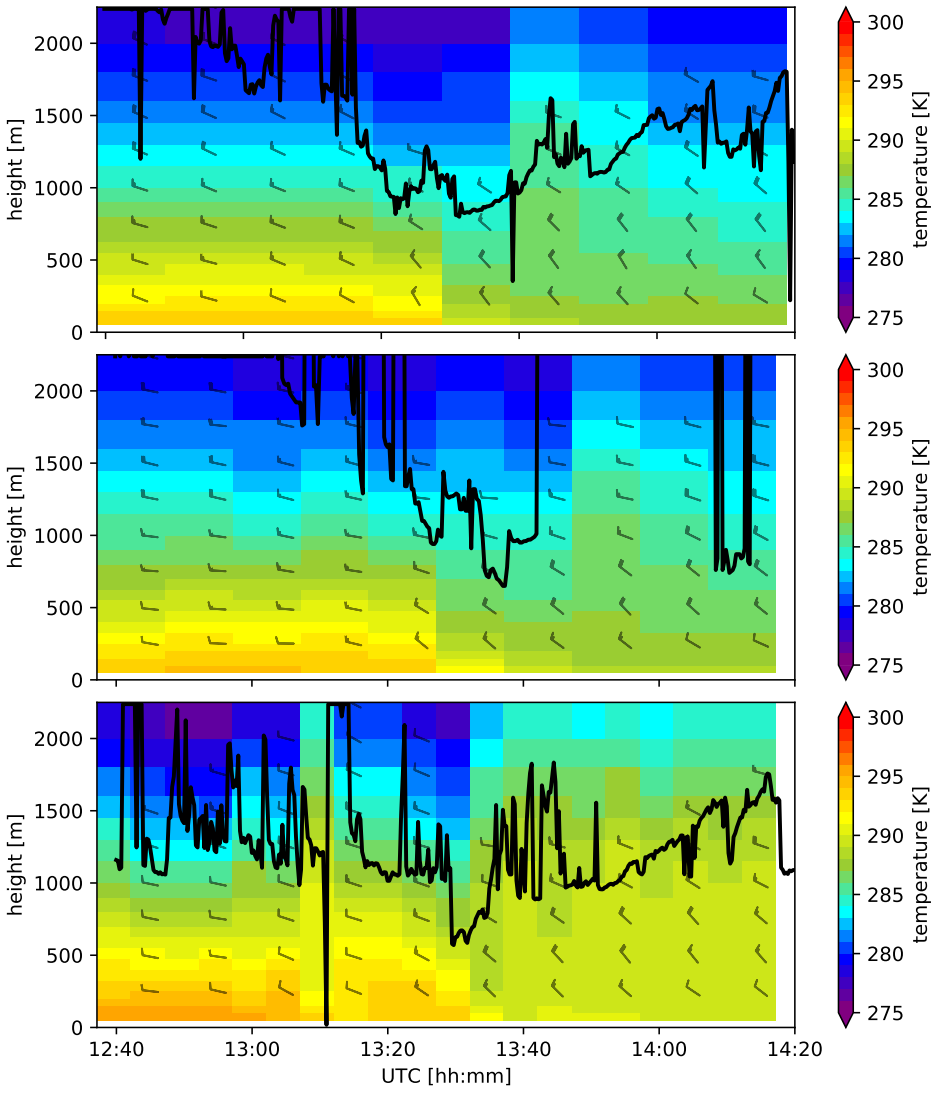
black line: lowest cloud base height from ceilometer;
wind barbs: 10 minutes horizontal wind direction

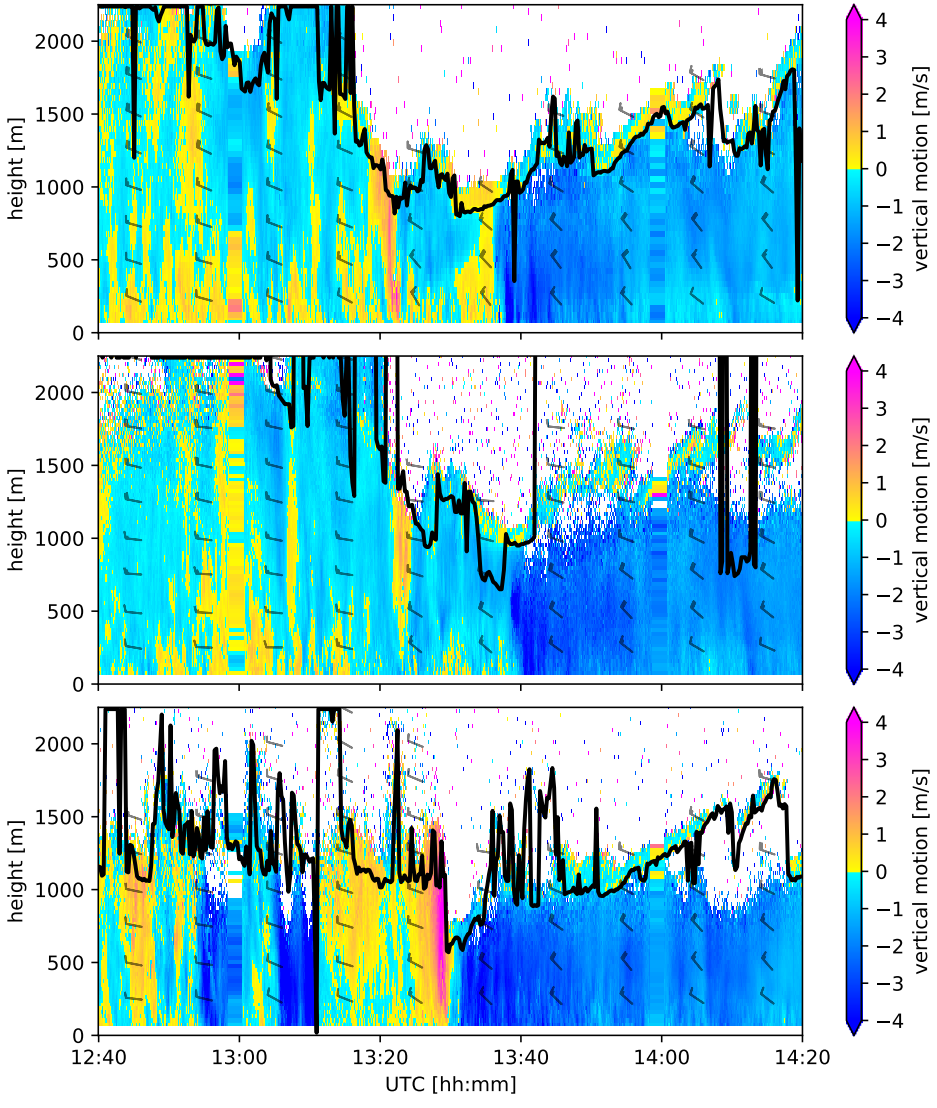
Triangle measuring cold front passage on 12.6.21 (12^{40} – 14^{20})

L

B

F



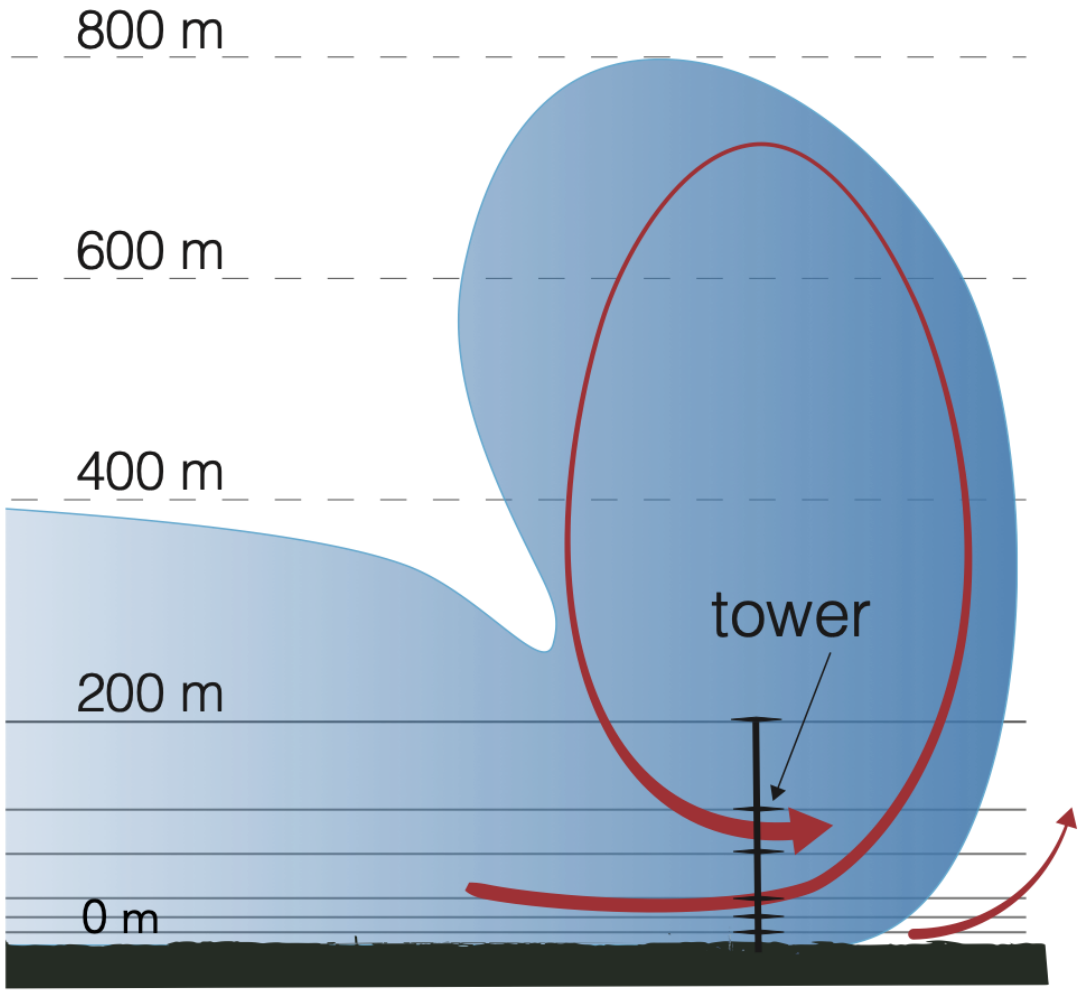


↑ MWRs

↑DWLs w-component

Cold pool Jogi (June 29, 2021)

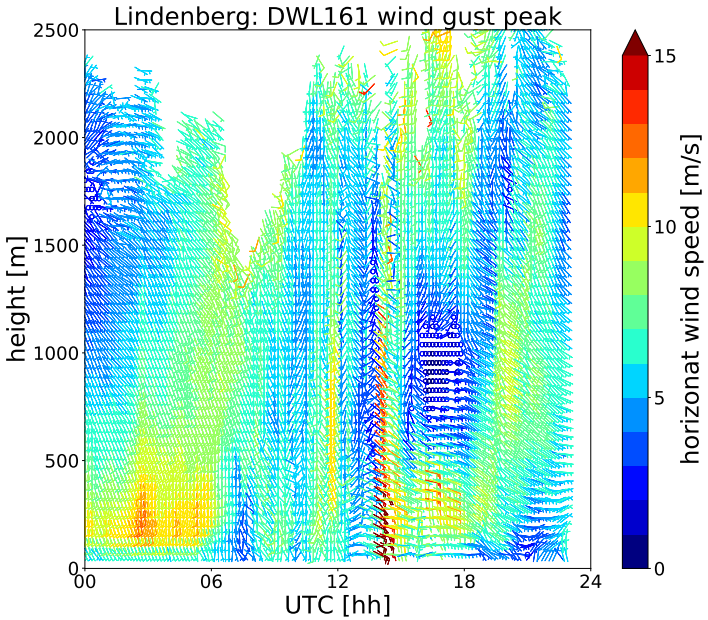
Scheme of a cold pool from Kruse, Haerter, and Meyer 2021

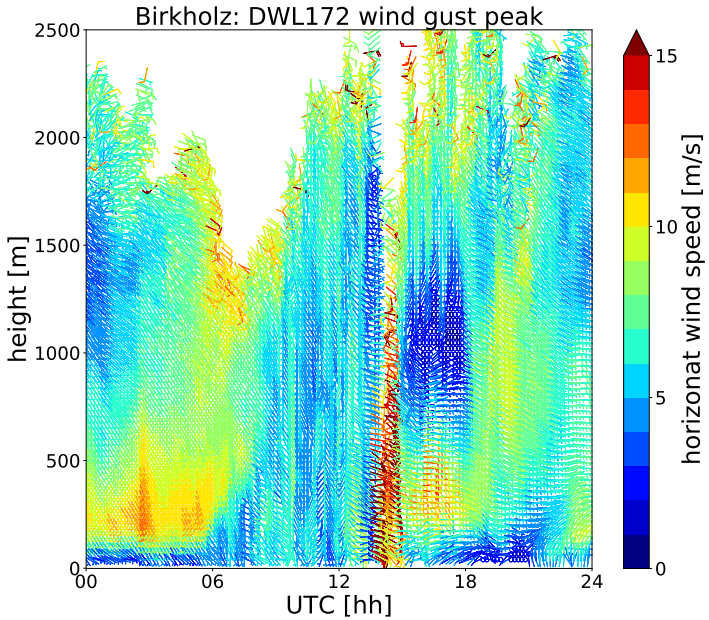


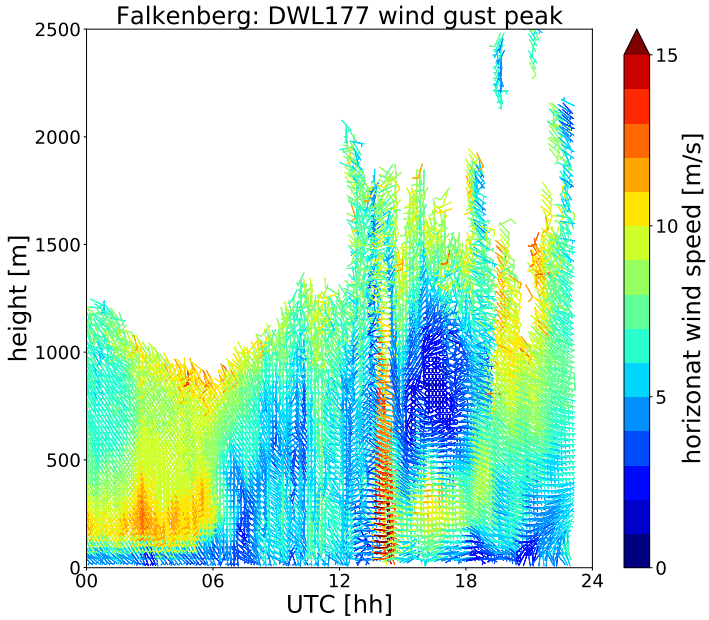
Cold pool blue shaded

Red arrows indicate the propagation velocity and internal circulation

Triangle measuring of cold pool Jogi on 29.6.21 (day)







Triangle measuring of cold pool Jogi on 29.6.21 (14^{00})

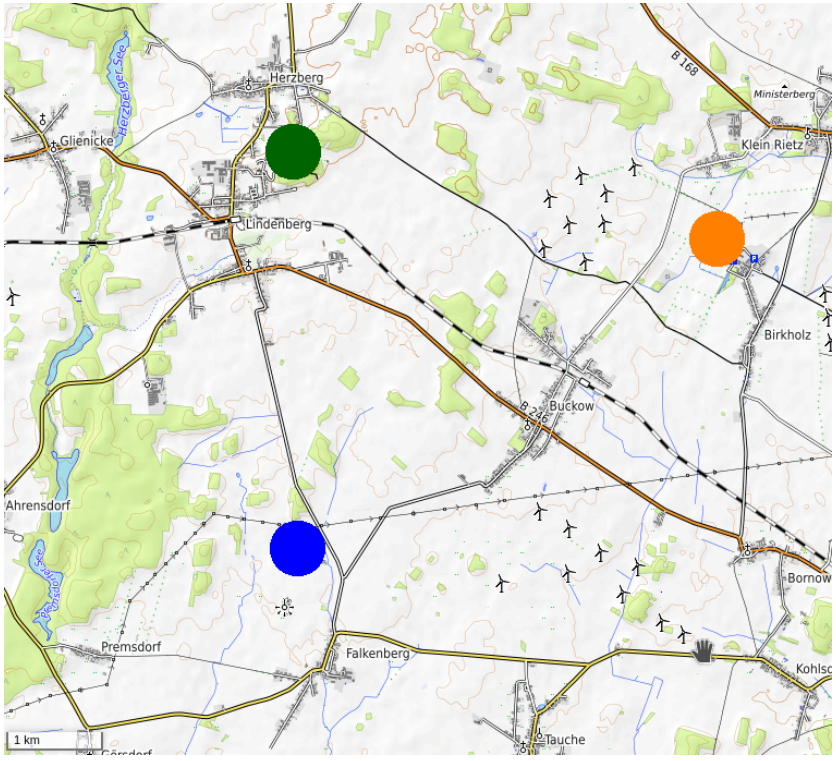


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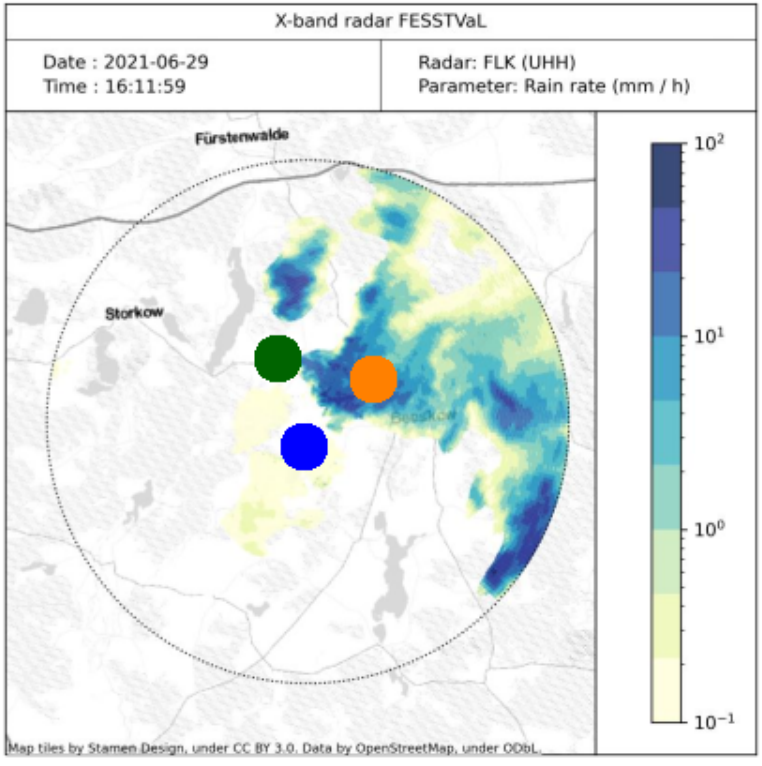
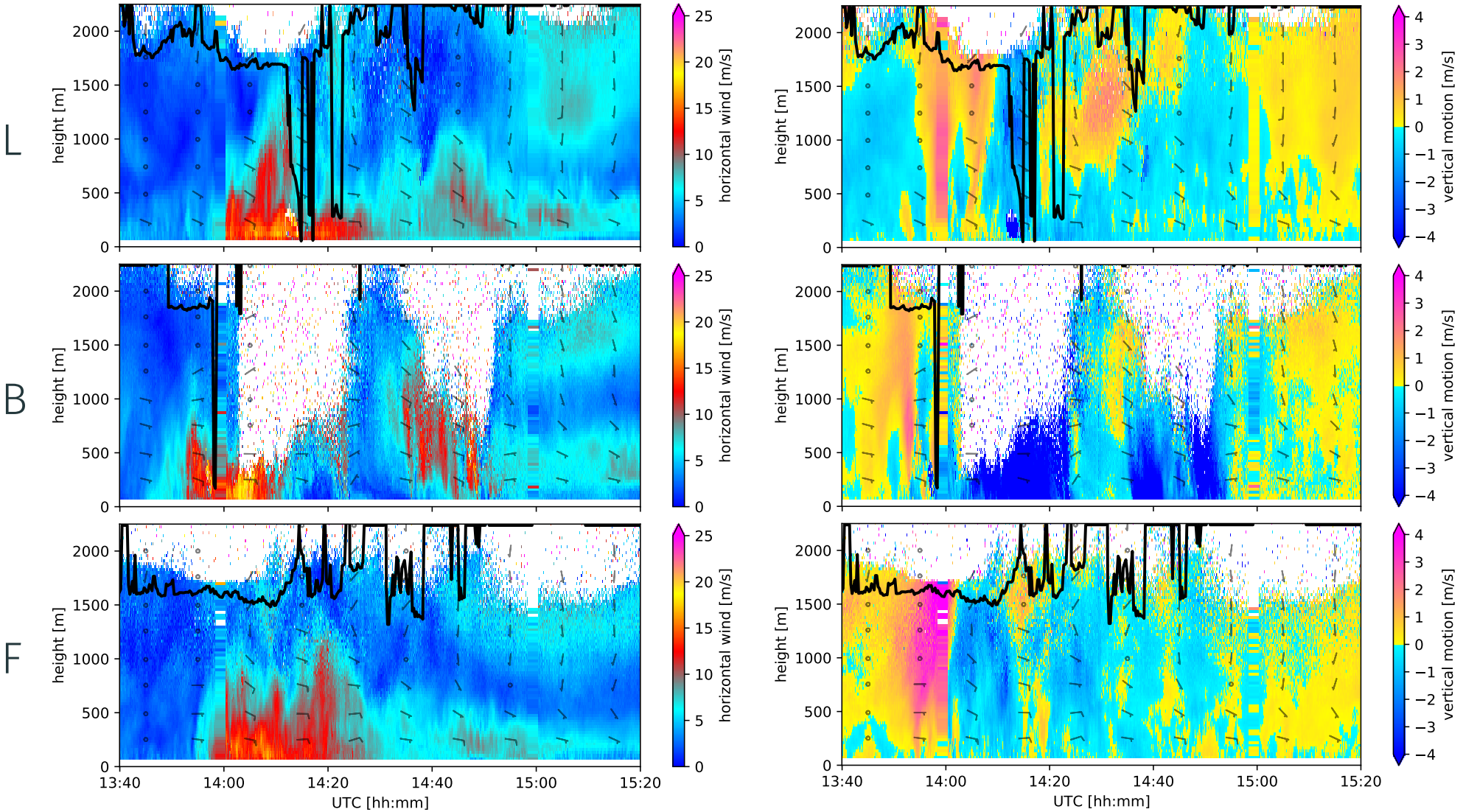
Figure 3: Locations of the three supersites 6 km apart from each other: Lindenberg (L), Birkholz (B), and Falkenberg (F).



Finn Burgemeister (Uni Hamburg)

Figure 4: Rain rate from the mobile X-band radar on June 29, 2021, 14 UTC (cold pool Jogi).

Triangle measuring of cold pool Jogi on 29.6.21 (13^{40} – 15^{20})



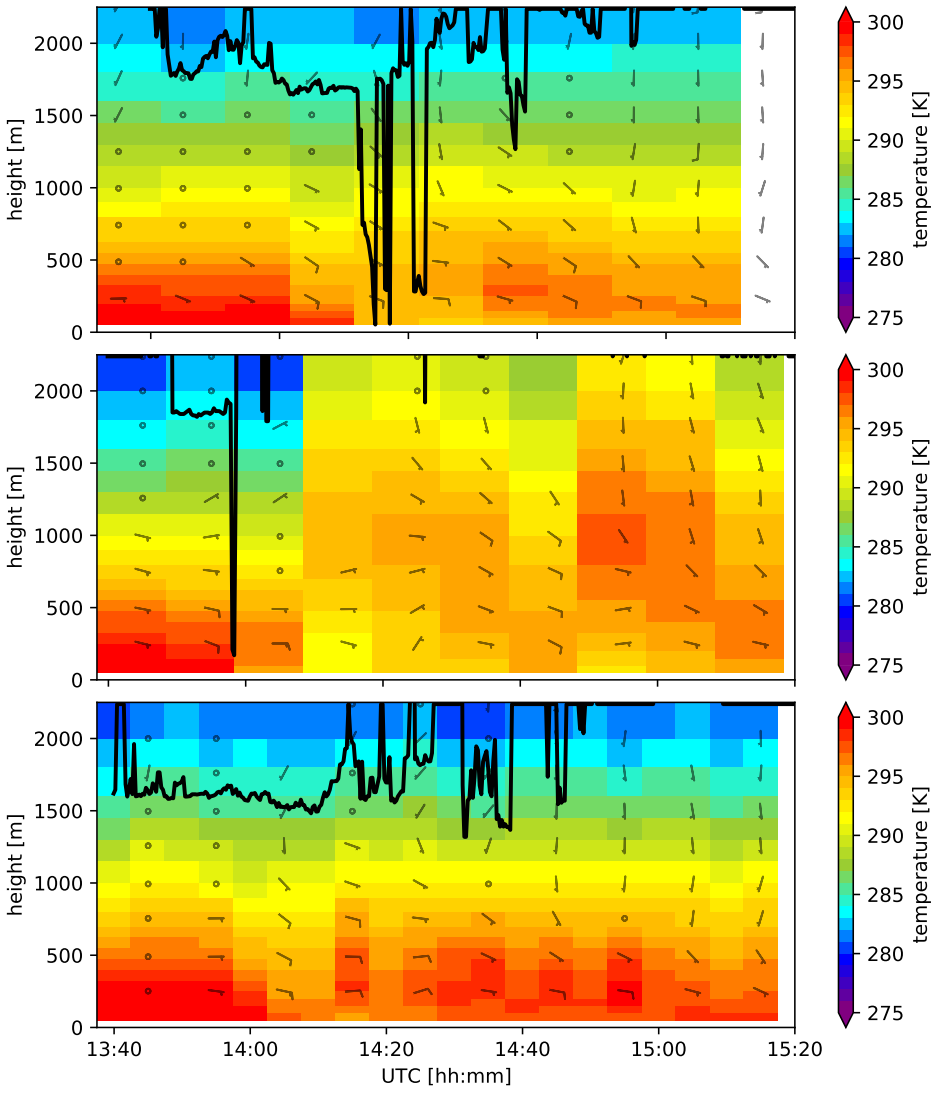
black line: lowest cloud base height from ceilometer;
wind barbs: 10 minutes horizontal wind direction

Triangle measuring of cold pool Jogi on 29.6.21 (13^{40} – 15^{20})

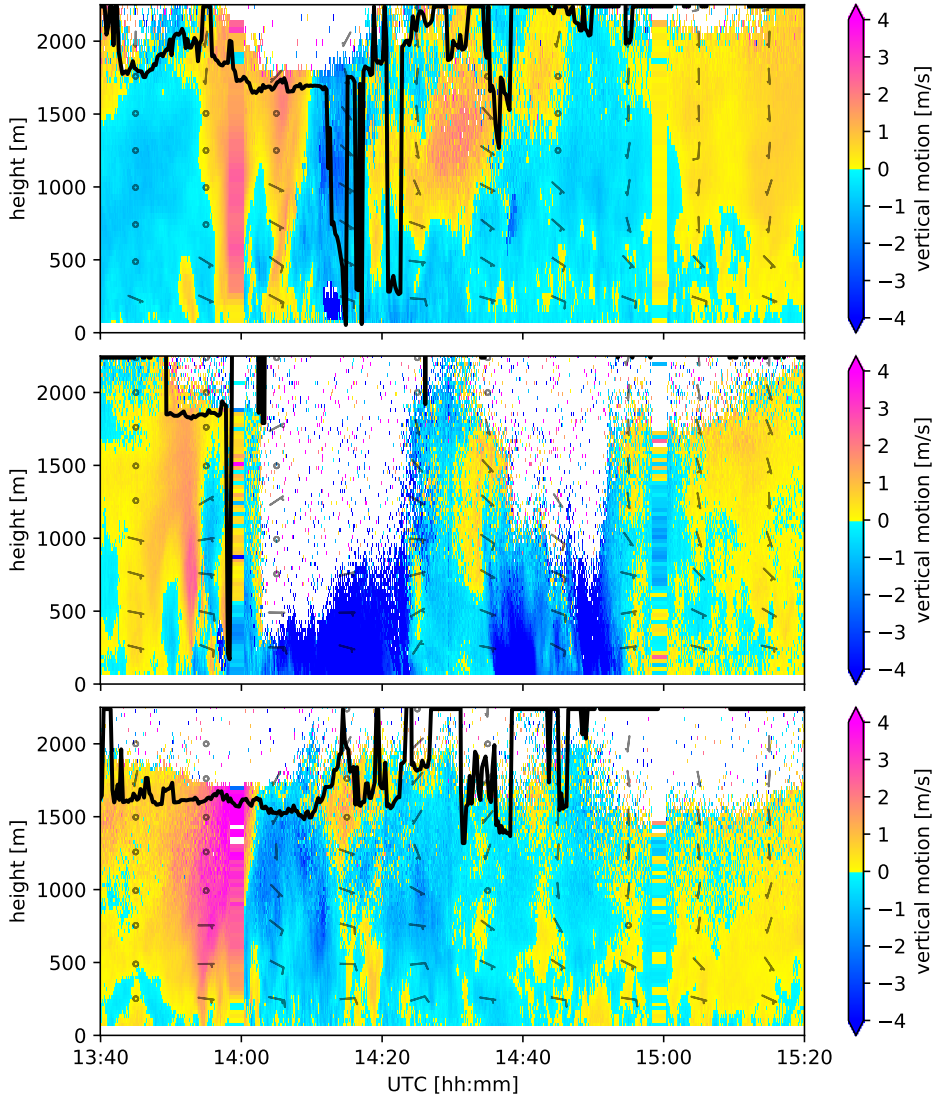
L

B

F

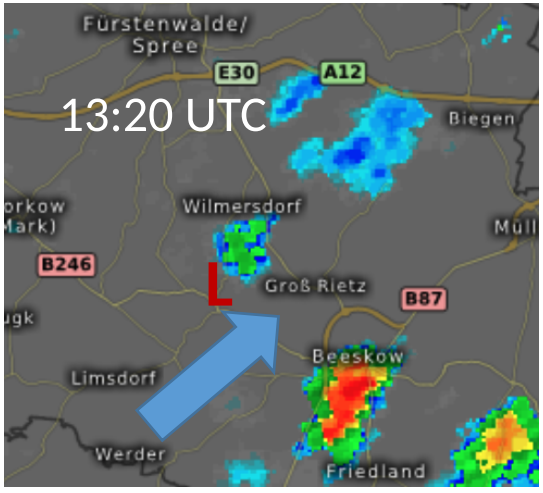


↑ MWRs



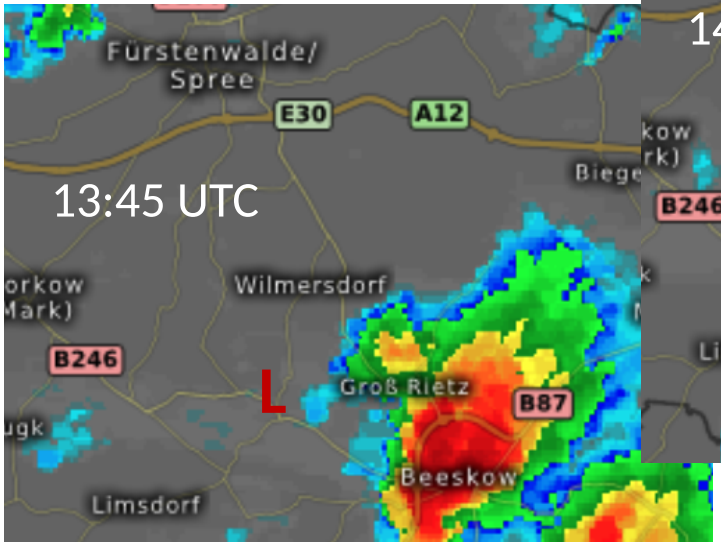
↑DWLs w-component

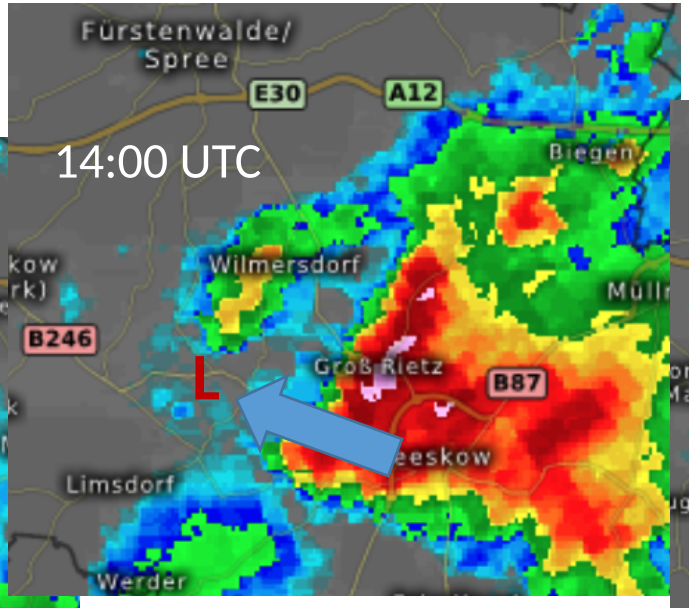
Triangle measuring of cold pool Jogi on 29.6.21 (13^{20} – 14^{15})

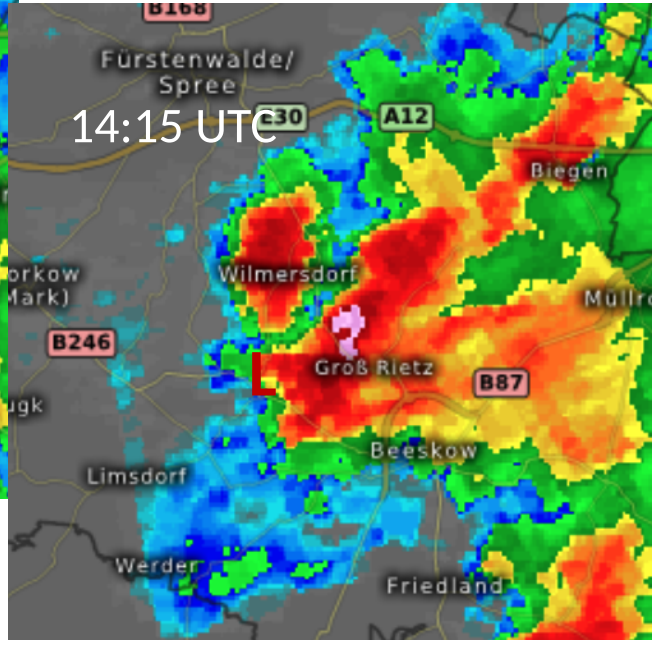


Before storm:
winds from SW

Close-by storm:
ABL winds from SO
= outflow region

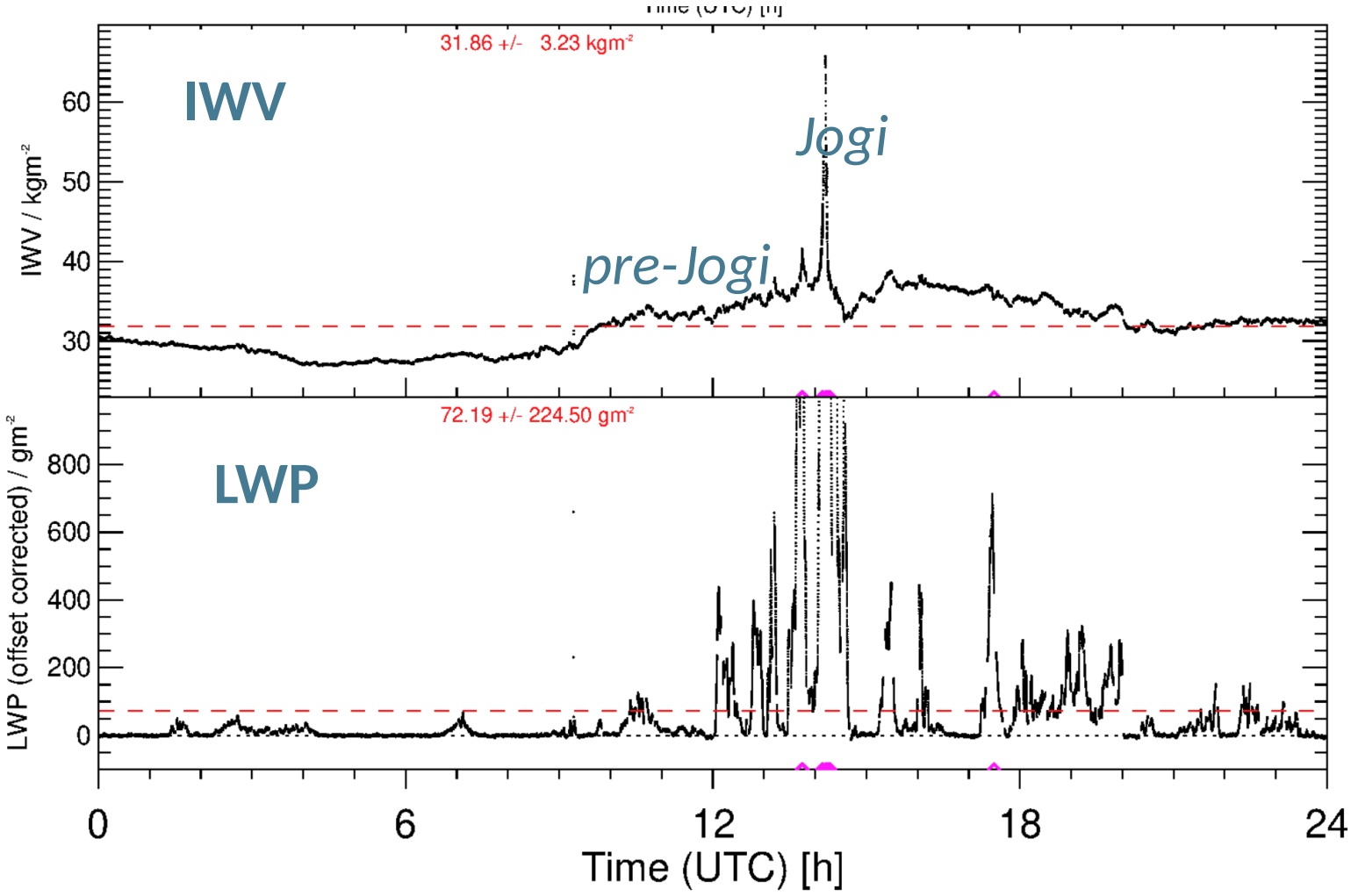






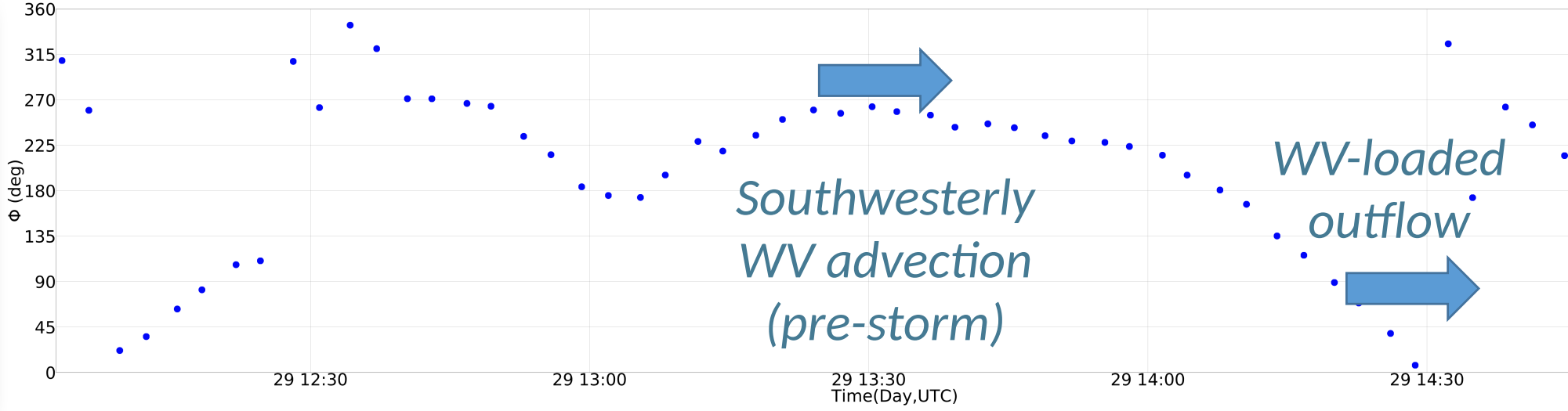
kachelmannwetter.com/de/regenradar/oder-spree/20210629.html

Water vapor cold pool Jogi on 29.6.21 (Lindenberg, day)

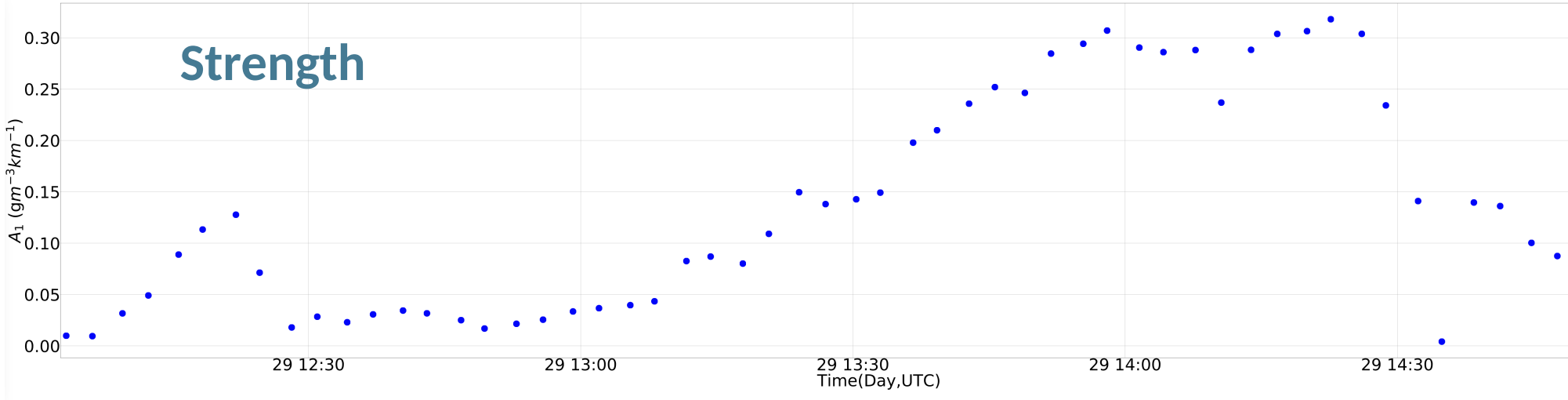


Water vapor gradients cold pool Jogi 29.6.21 (Lindenberg, 12 – 15)

Direction



Strength



Conclusion

Conclusion

→ triangle configuration has potential to see evolution of gust, temperature, and humidity patterns in stormy summer days

→ investigate further cases in synergy with other observations (Apollo & WXT network HH, UAVs)

→ maybe further case studies (suggestions?)

→ present at EGU next week, EMS in autumn

! finnish PhD this year with 3rd paper !

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