Lukas Pfitzenmaier, Pavlos Kollias, and Ulrich Löhnert

Retrieving antenna miss-pointing for vertical pointing cloud radar and correcting the introduced Doppler velocity errors in the measurements

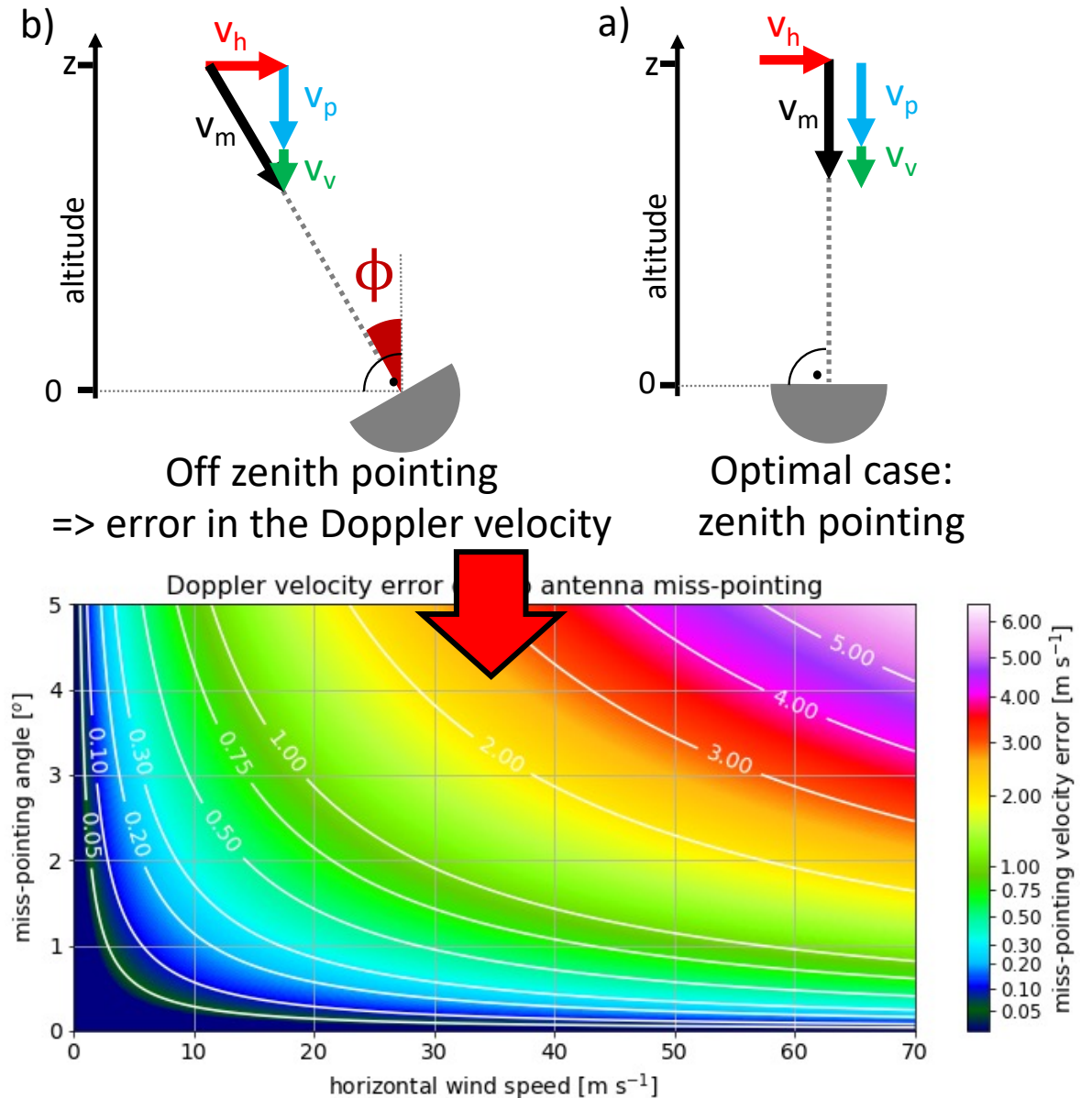Doppler velocity from zenith pointing radars

- Mean fall velocity of measured hydrometeors
- No absolute calibration needed
- Excellent information cloud microphysics and dynamics

Best quality Doppler velocity data

➢ What is the velocity error due to antenna miss-pointing?
➢ Can we monitor the radar pointing accuracy?
➢ How to correct long time data sets?

Statistical method:
model winds (ECMWF IFS)
Doppler velocity data

➢ Correction of historical measurements

Off zenith pointing
=> error in the Doppler velocity

Optimal case:
zenith pointing

Doppler velocity error due to antenna miss-pointing
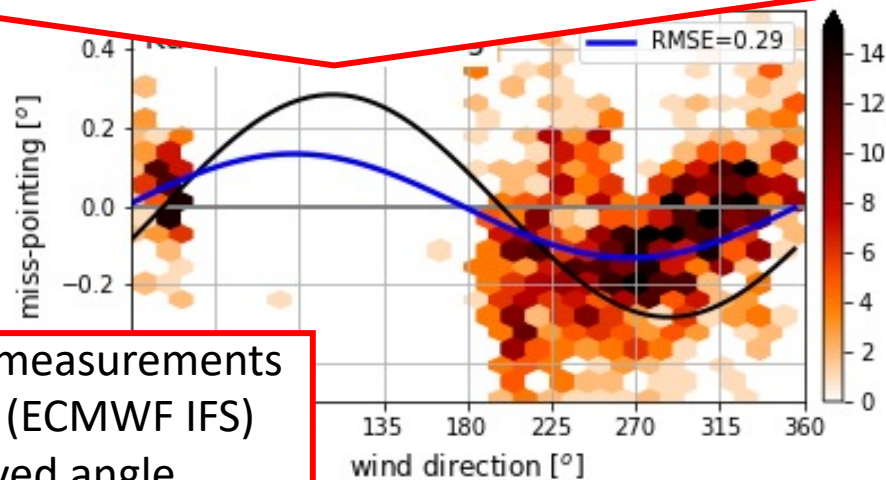
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Retrieving antenna miss-pointing for vertical pointing cloud radar and correcting the introduced Doppler velocity errors in the measurements
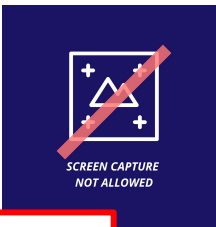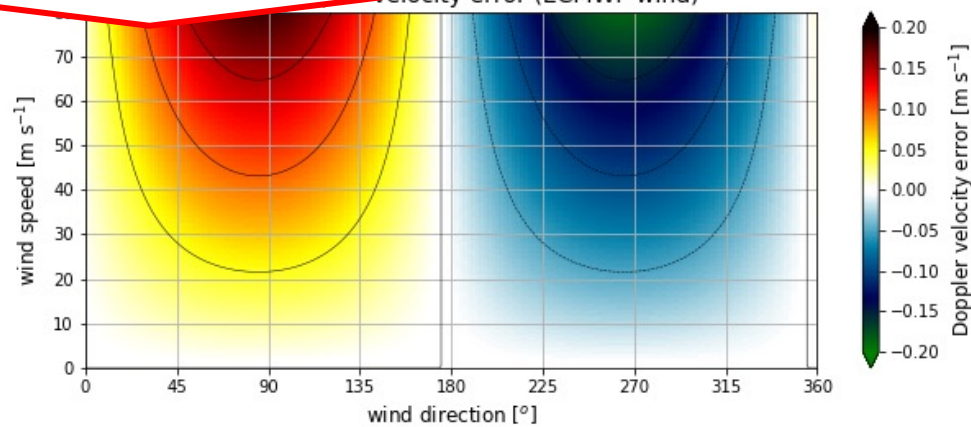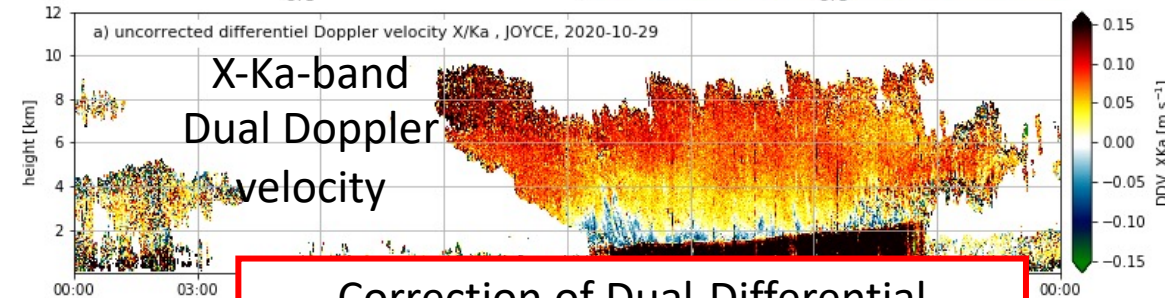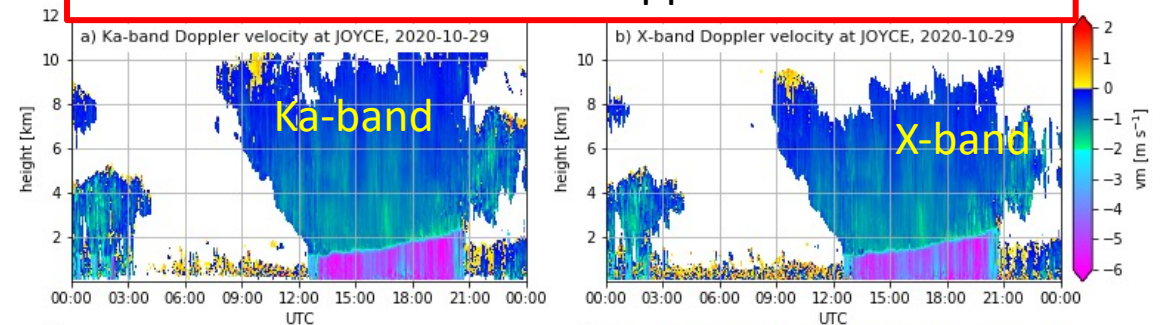
Statistical method
- Bin Vm and Vh according to the wind direction
- Calculate off-zenith pointing angles
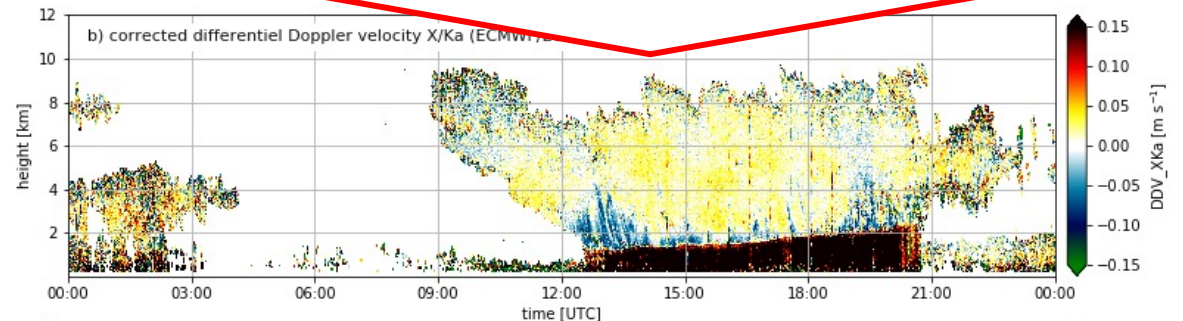- Retrieve off-zenith pointing angle based on fit

EXAMPLE: Cross check
Correct Dual-Differential Doppler measurements

Correction of measurements
-> wind field (ECMWF IFS)
-> retrieved angle

Correction of Dual-Differential
Doppler velocity radar measurements
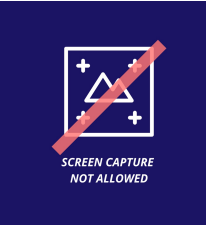
MATERIAL FOR DISCUSSION:
Retrieving antenna miss-pointing for vertical pointing cloud radar and correcting the introduced Doppler velocity errors in the measurements

Lukas Pfitzenmaier, Pavlos Kollias, and Ulrich Löhnert

Motivation:

Control the quality of the Doppler Velocity data

Mean Doppler velocity is grate, because
- free from absolute calibration
- proportional to the hydrometeor fall velocities

➢Information about hydrometeor microphysics
- dual/triple Doppler velocity space (increasing data set)
- Input for retrievals

➢Satellite mission validation
- Aeolus and EarthCare

➢ Provide best quality ground based Doppler velocity data

How big is the influence of off-zenith pointing antennas?

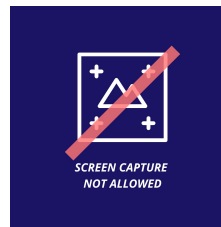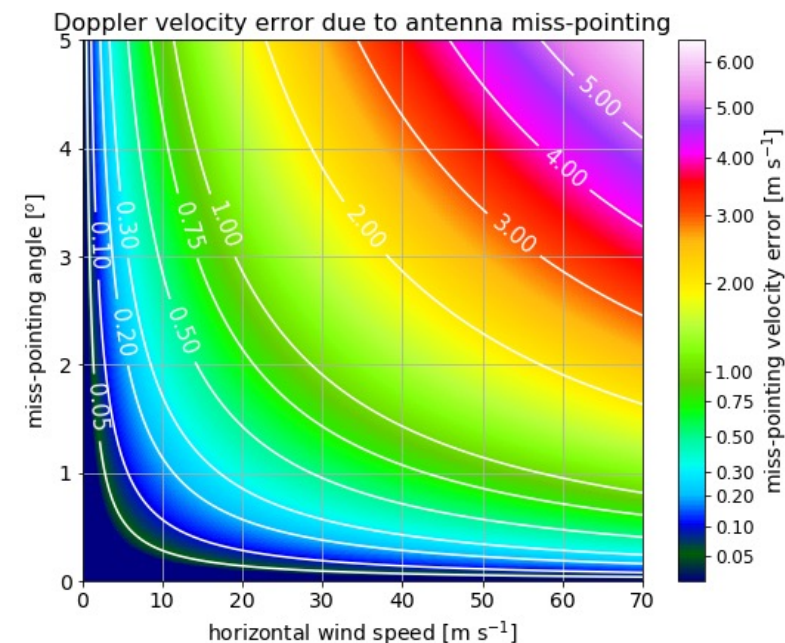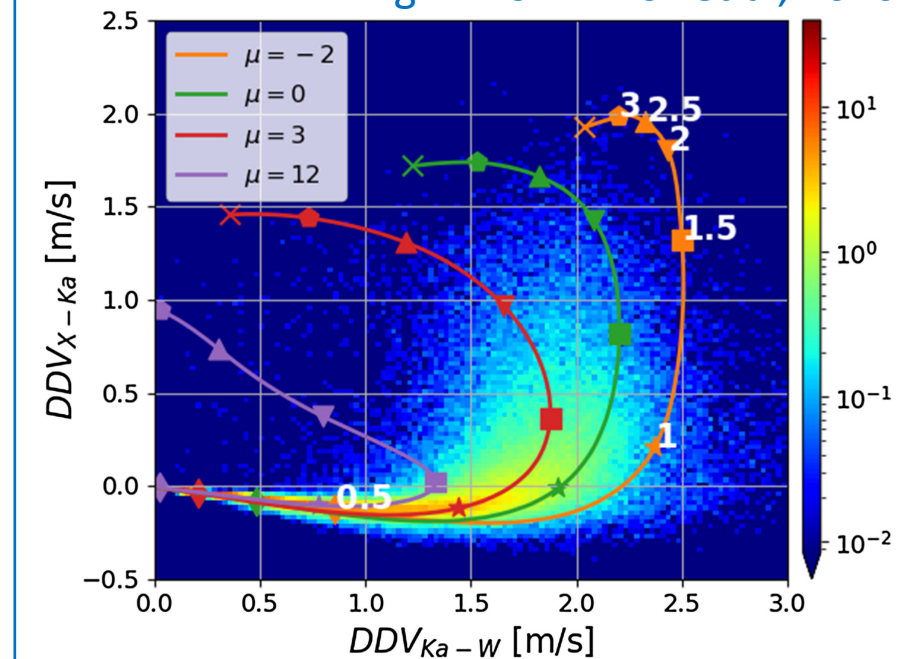**How can we monitor and correct the data?**

fig. 2 from Mroz et.al, 2020

Doppler velocity error due to antenna miss-pointing

Retieval

How big is the influence of off-zenith pointing antennas?

How can we monitor and correct the data?

Error due to off-zenith pointing:

- Proportional to mean horizontal wind speed, v_h
- Proportional to off-zenith pointing angle, ϕ

Use of additional wind information:

- ECMWF IFS data for wind (included in Cloudnet)
- Possible to correct historical data
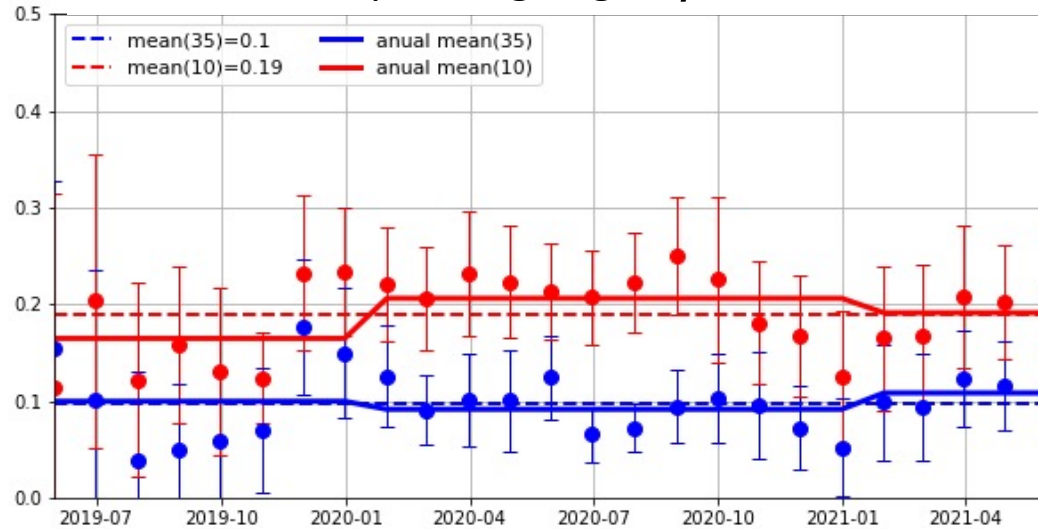 - *PPI scans to retrieve wind (available at JOYCE)*

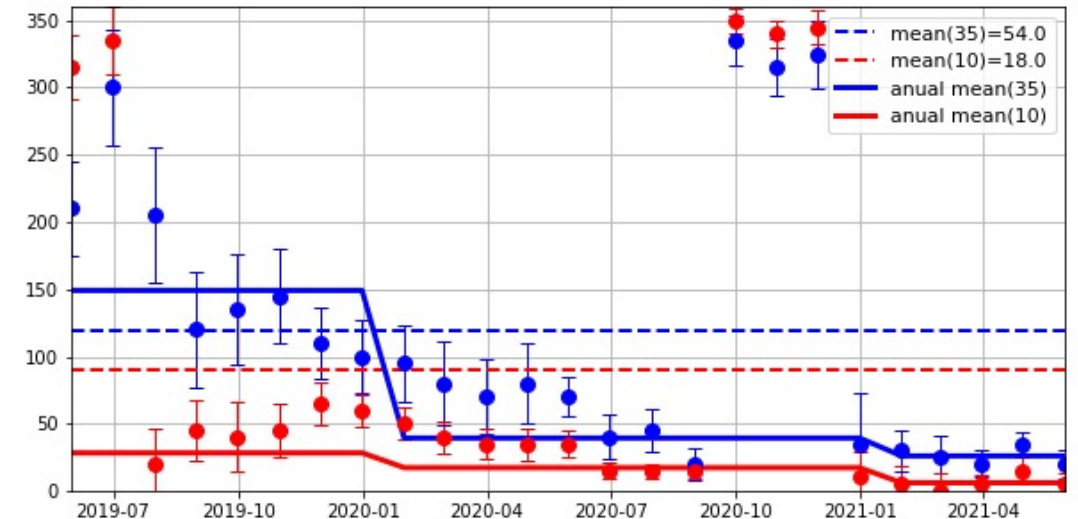Long term wind statistic to retrieve off-zenith pointing angle based on sin-fit to data

$$v_m = (v_v + v_p)\sin(90°)$$

$$v_m = \sin(90° \pm \phi)\, v_h$$
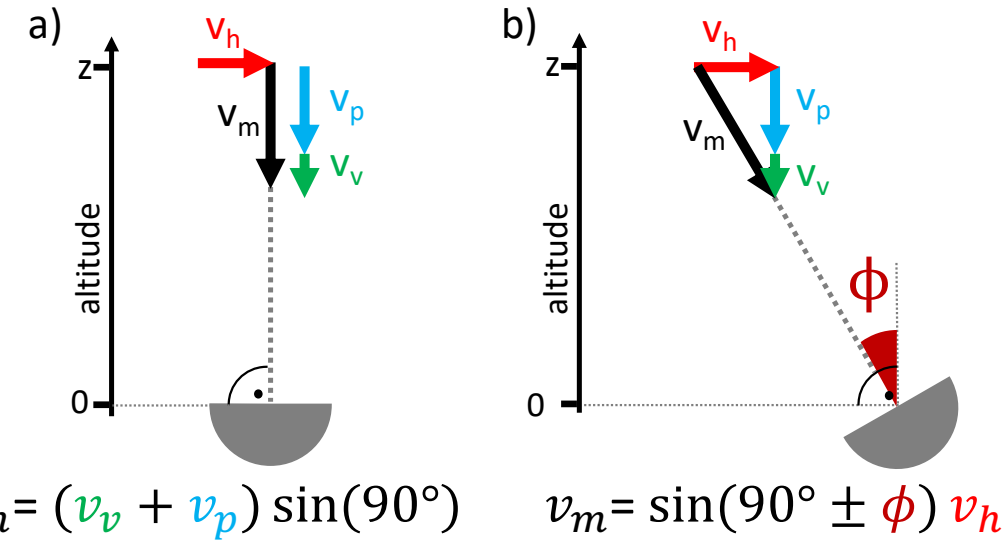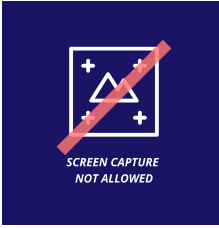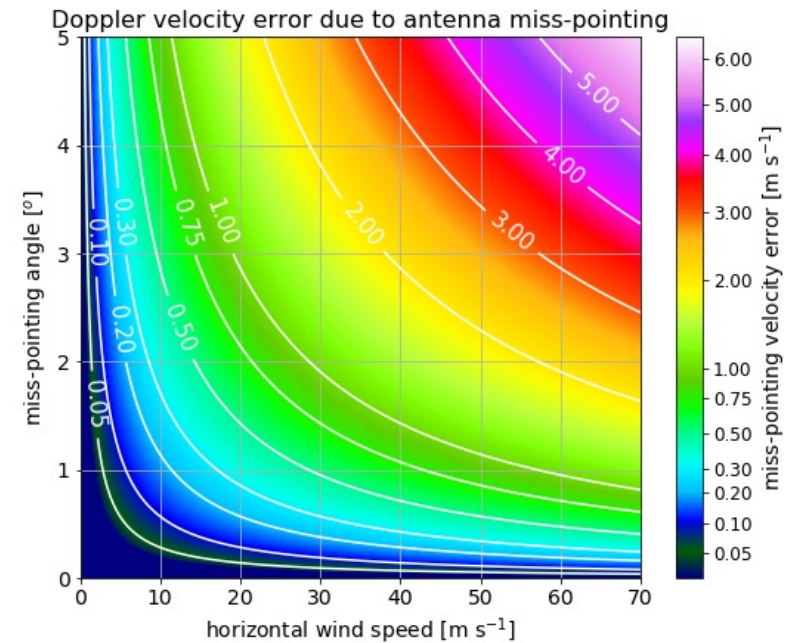
Vm = Doppler velocity (measurement)   Vh = mean horizontal wind speed
Vv = mean vertical wind Speed   Vp = mean particle fall velocity

Results

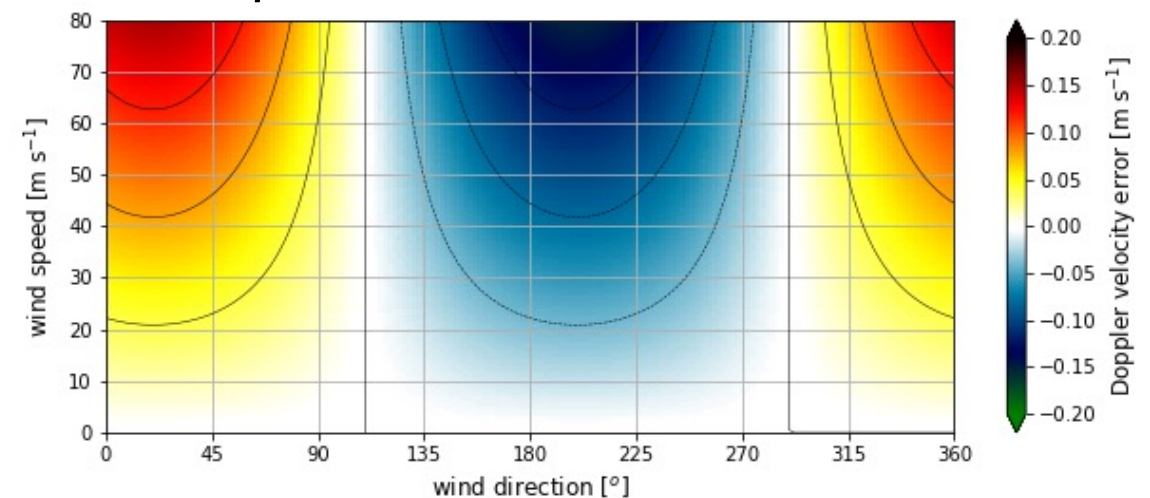### off-zenith pointing angle, ϕ, time series

time series of azimuth pointing of ϕ
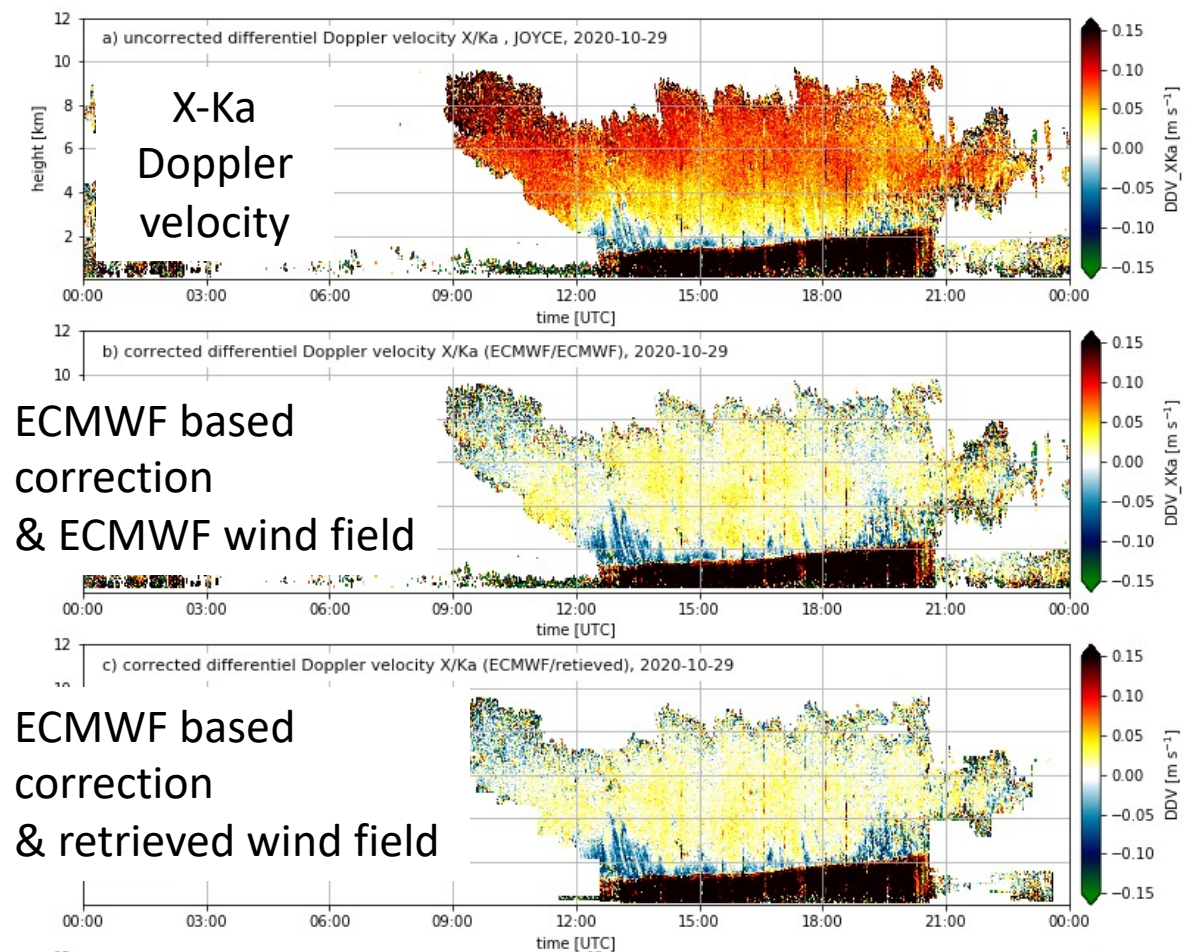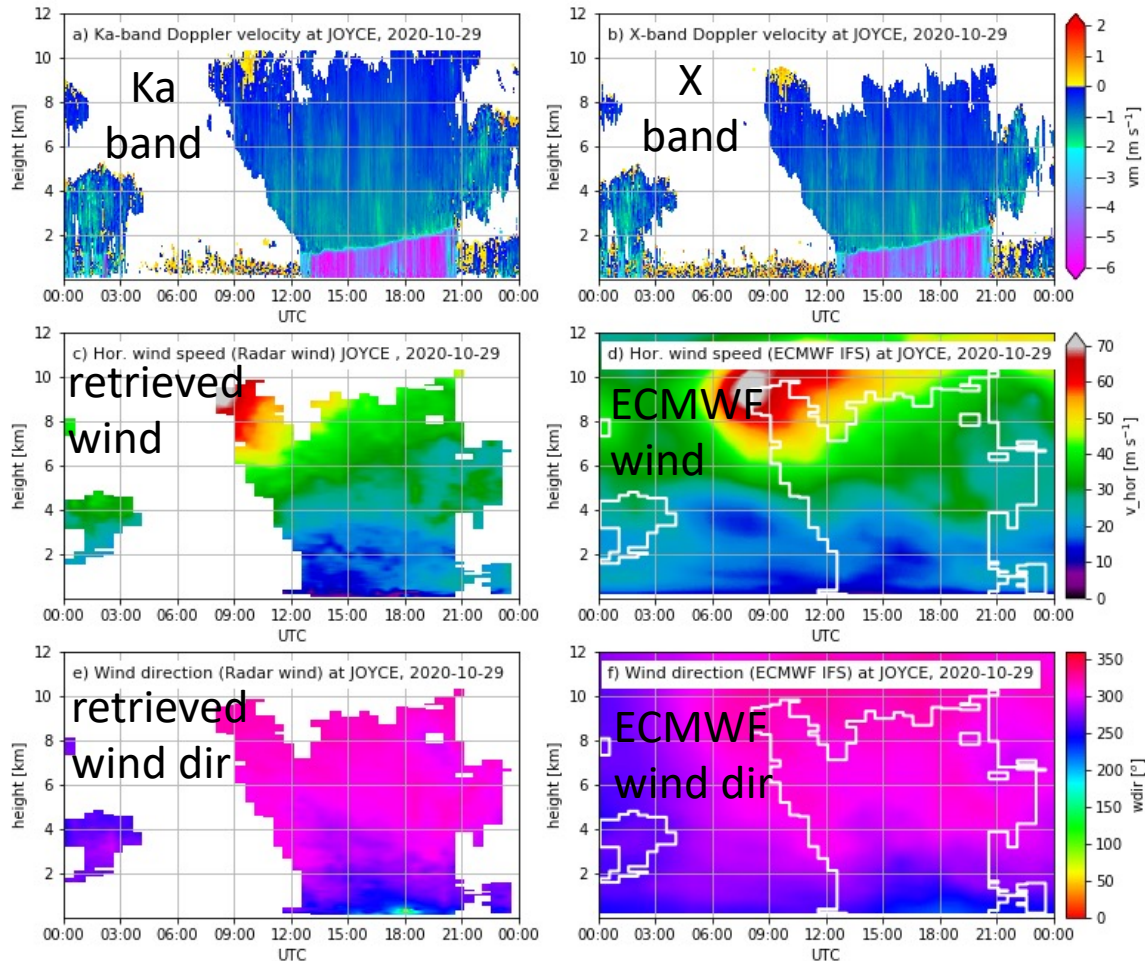

- Off-zenith pointing retrieved with ECMWF wind
  - ➤ < 6 month wind statistics
- Results compared to ϕ retrieved with sun scans ar within 0.02° (Mai-June 2021)
- Correction of past data sets based on retrieved angles and wind information (ECMWF or retrieved

Doppler velocity correction based on retrieved ϕ and additional wind information
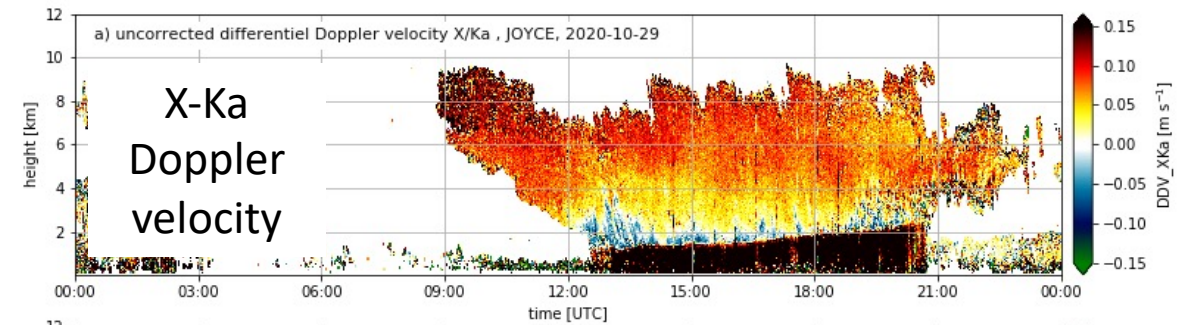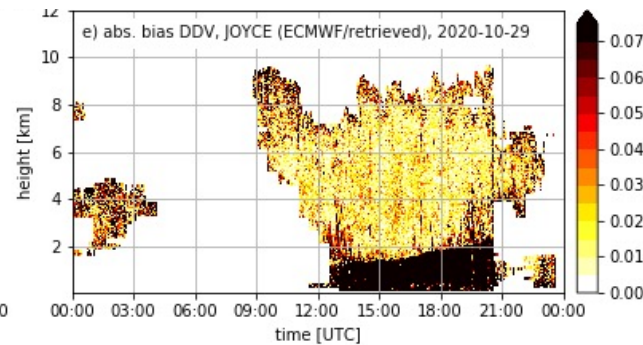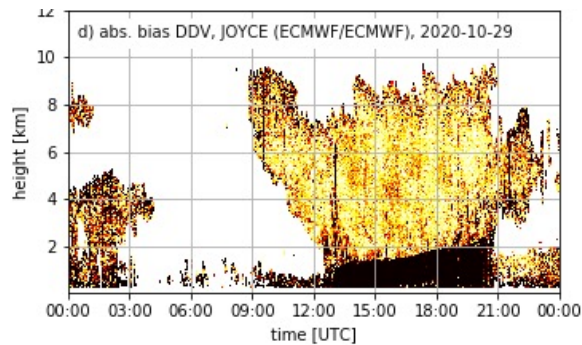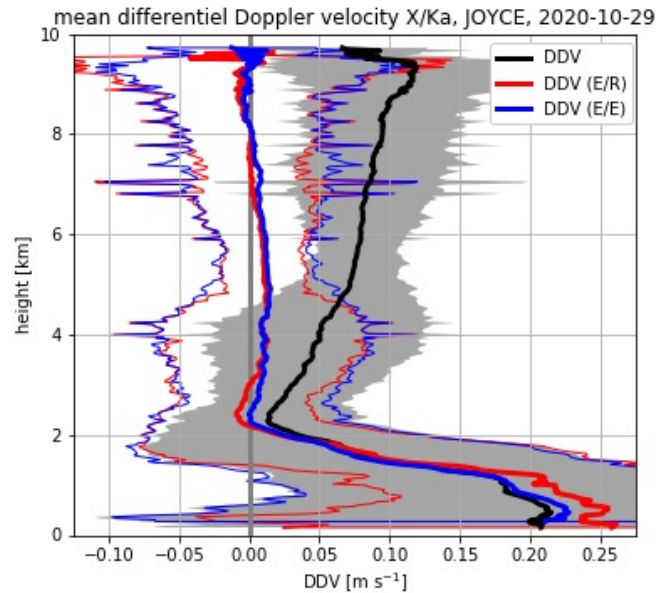
Results: Example Case 29-10-2020, JOYCE

Results: Example Case 29-10-2020. JOYCE

mean differentiel Doppler velocity X/Ka, JOYCE, 2020-10-29

a) uncorrected differentiel Doppler velocity X/Ka , JOYCE, 2020-10-29

X-Ka Doppler velocity

b) corrected differentiel Doppler velocity X/Ka (ECMWF/ECMWF), 2020-10-29

ECMWF based correction & ECMWF wind field

d) abs. bias DDV, JOYCE (ECMWF/ECMWF), 2020-10-29

e) abs. bias DDV, JOYCE (ECMWF/retrieved), 2020-10-29

c) corrected differentiel Doppler velocity X/Ka (ECMWF/retieved), 2020-10-29
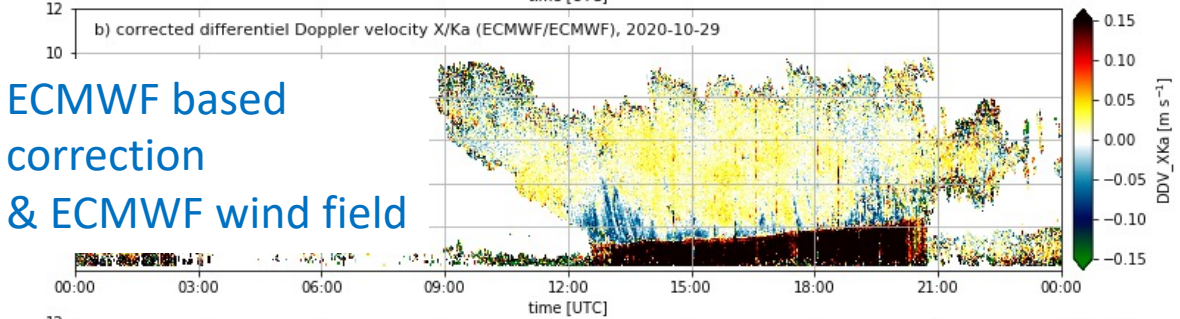
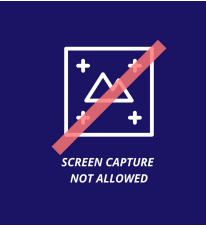ECMWF based correction & retrieved wind field
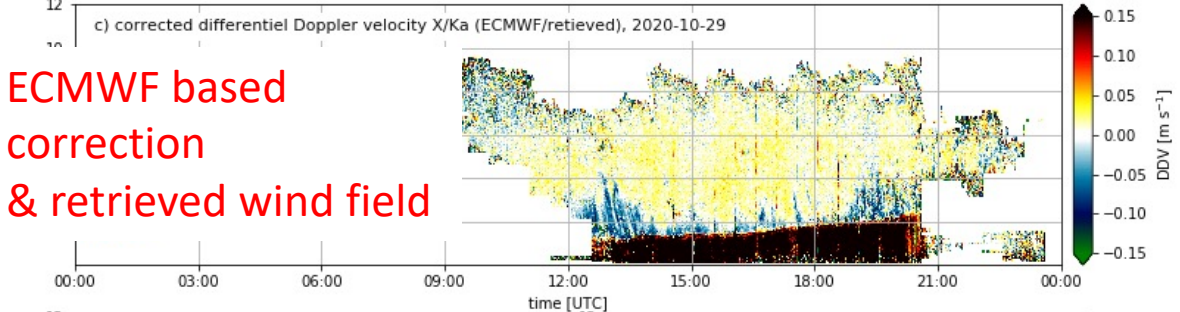
Conclusion:

- Off zenith pointing can lead to error in the Doppler velocity

- Estimation/Correction of the off-zenith pointing is estimated
    - wind information
    - Statistical method

- Monitoring and Correction of the Doppler velocity is also possible for historical data sets
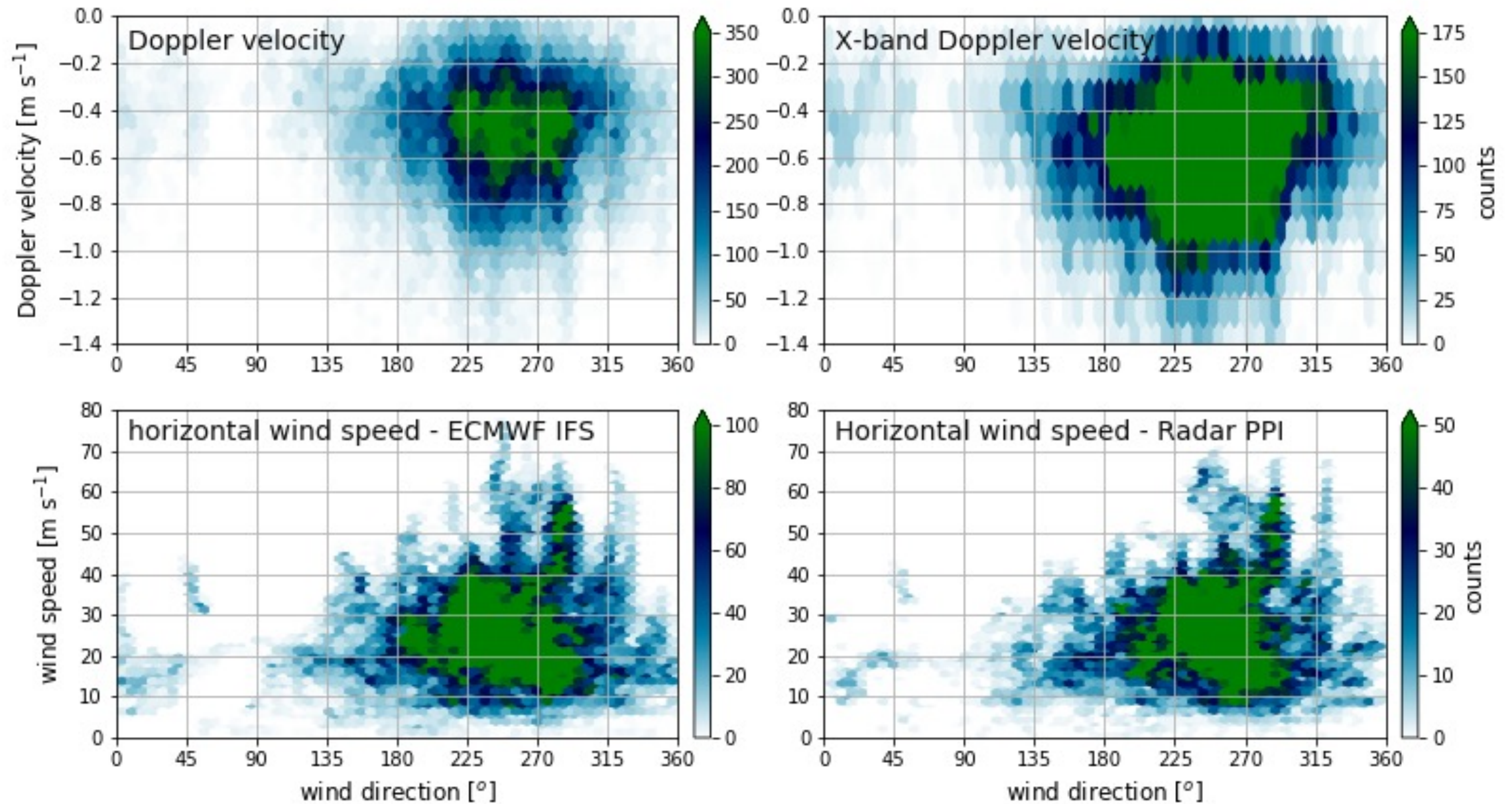
BACKUP SLIDES:
Retrieving antenna miss-pointing for vertical pointing cloud radar and correcting the introduced Doppler velocity errors in the measurements
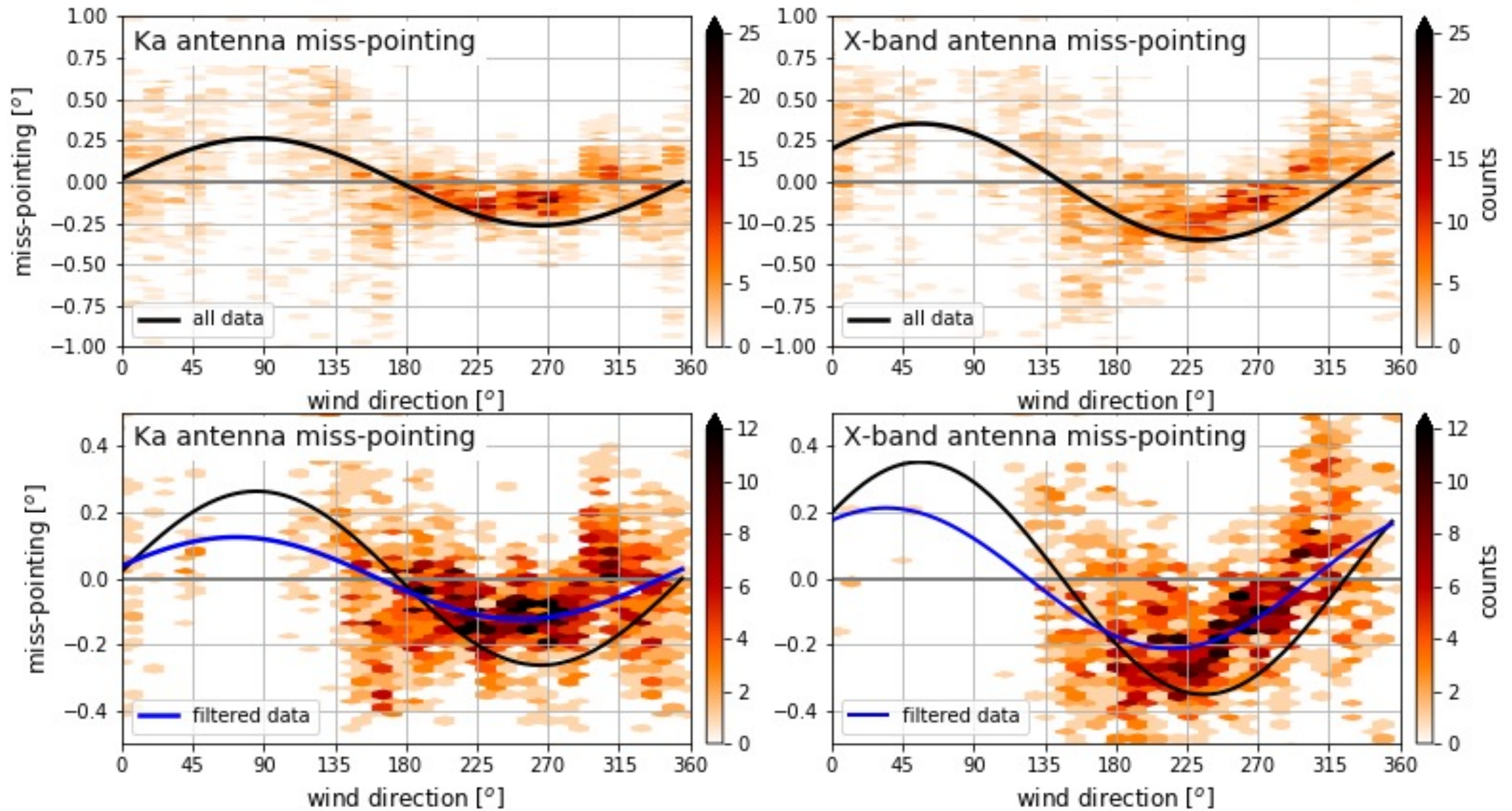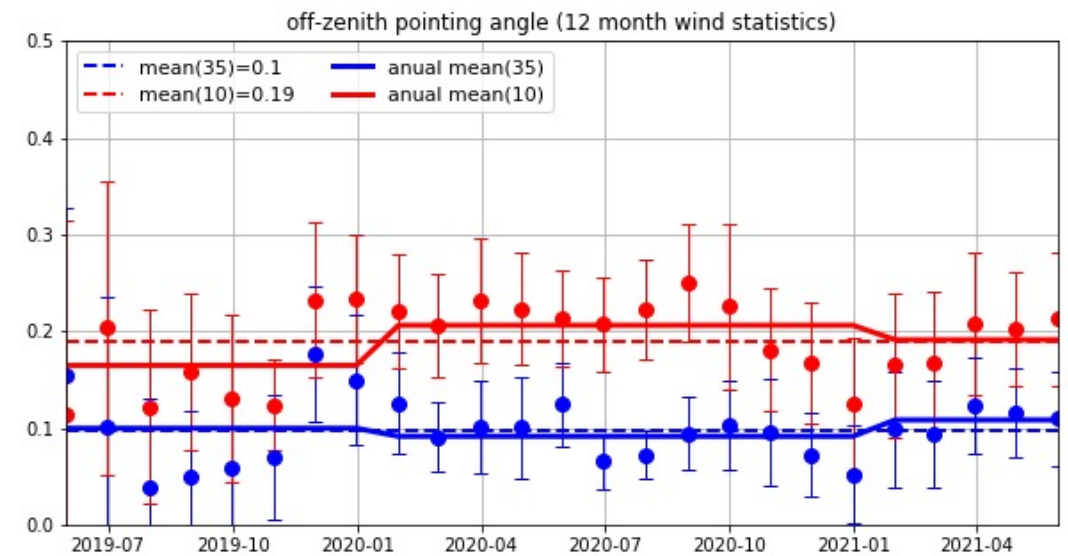
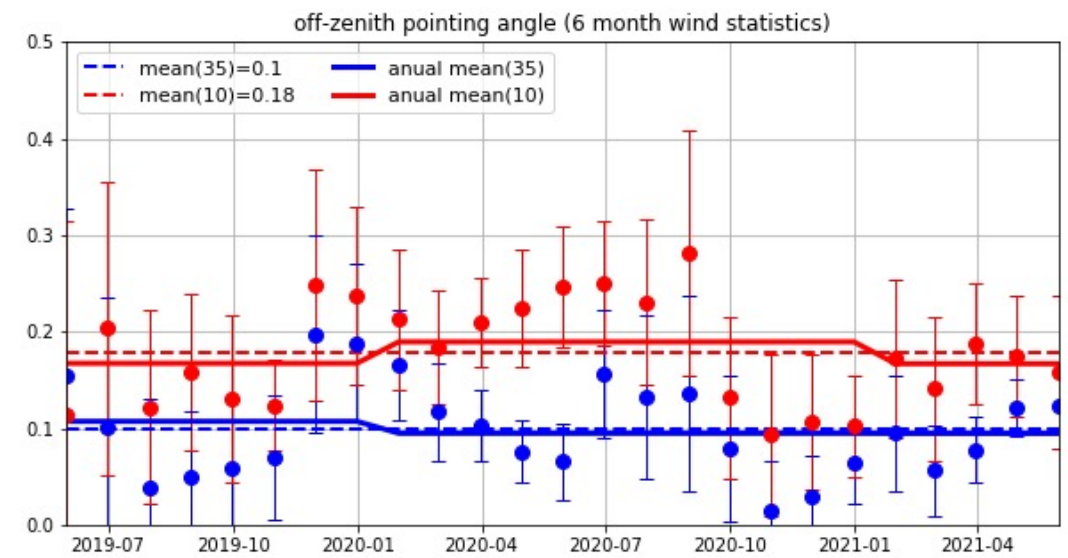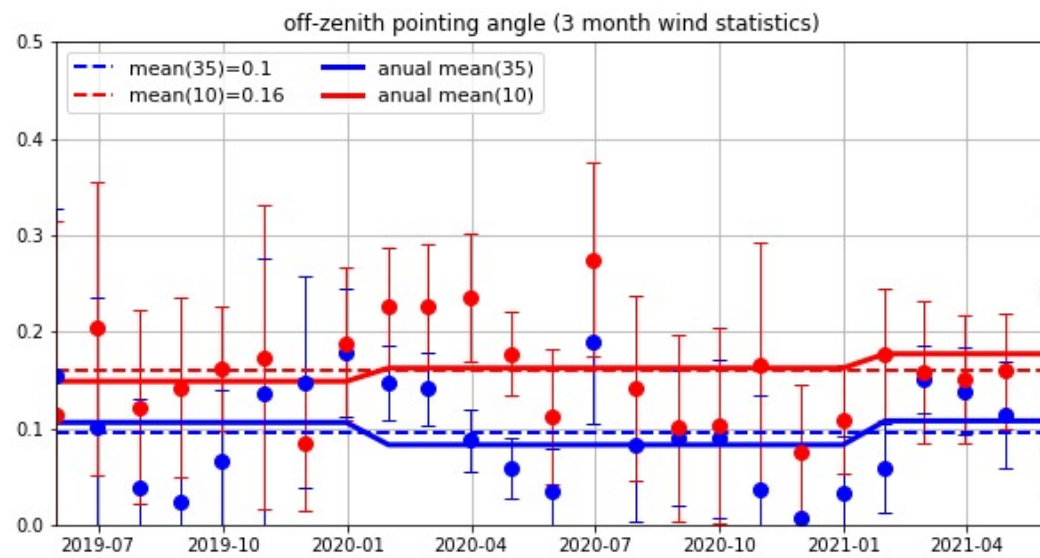**Lukas Pfitzenmaier**, Pavlos Kollias, and Ulrich Löhnert
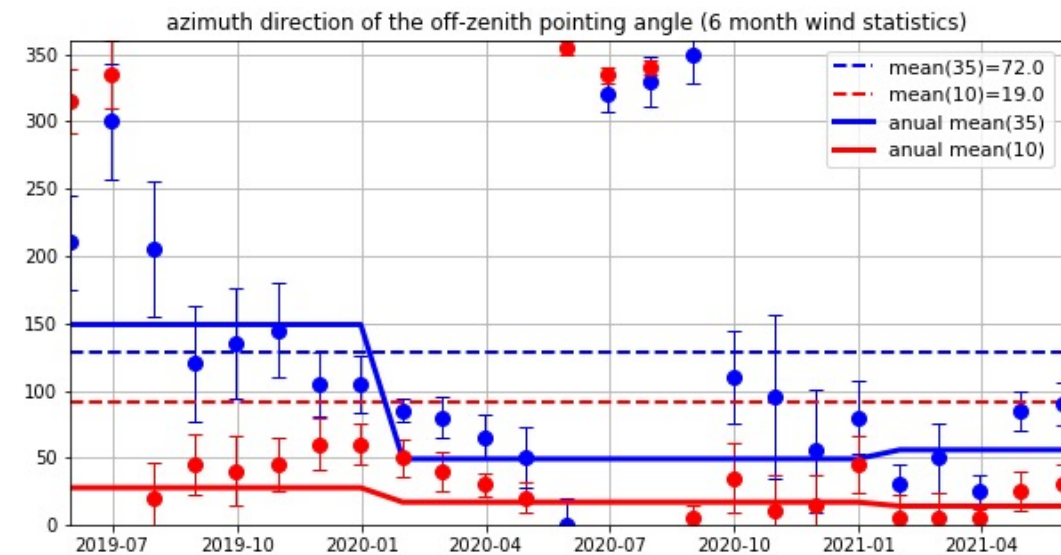
Input ECMWF IFS and PPI wind retrieval

Final sun-fit to the data set to retrieve the angles,
apply a filter to get stabler estimates (95-5percentile data set & <2data bins)

off-zenith pointing angle (3 month wind statistics)

off-zenith pointing angle (6 month wind statistics)

off-zenith pointing angle (12 month wind statistics)

Das X-Band hatte relativ zum Mira ein **mis-pointing von etwa 0.14°** in N-S Richtung

Mira-36 um 0.08° korrikiert (mis-pointing maximum in O-W Richtung)

azimuth direction of the off-zenith pointing angle (3 month wind statistics)

azimuth direction of the off-zenith pointing angle (6 month wind statistics)

azimuth direction of the off-zenith pointing angle (12 month wind statistics)

Das X-Band hatte relativ zum Mira ein mis-pointing von etwa 0.14° in **N-S Richtung**

Mira-36 um 0.08° korrikiert (mis-pointing maximum in **O-W Richtung**)