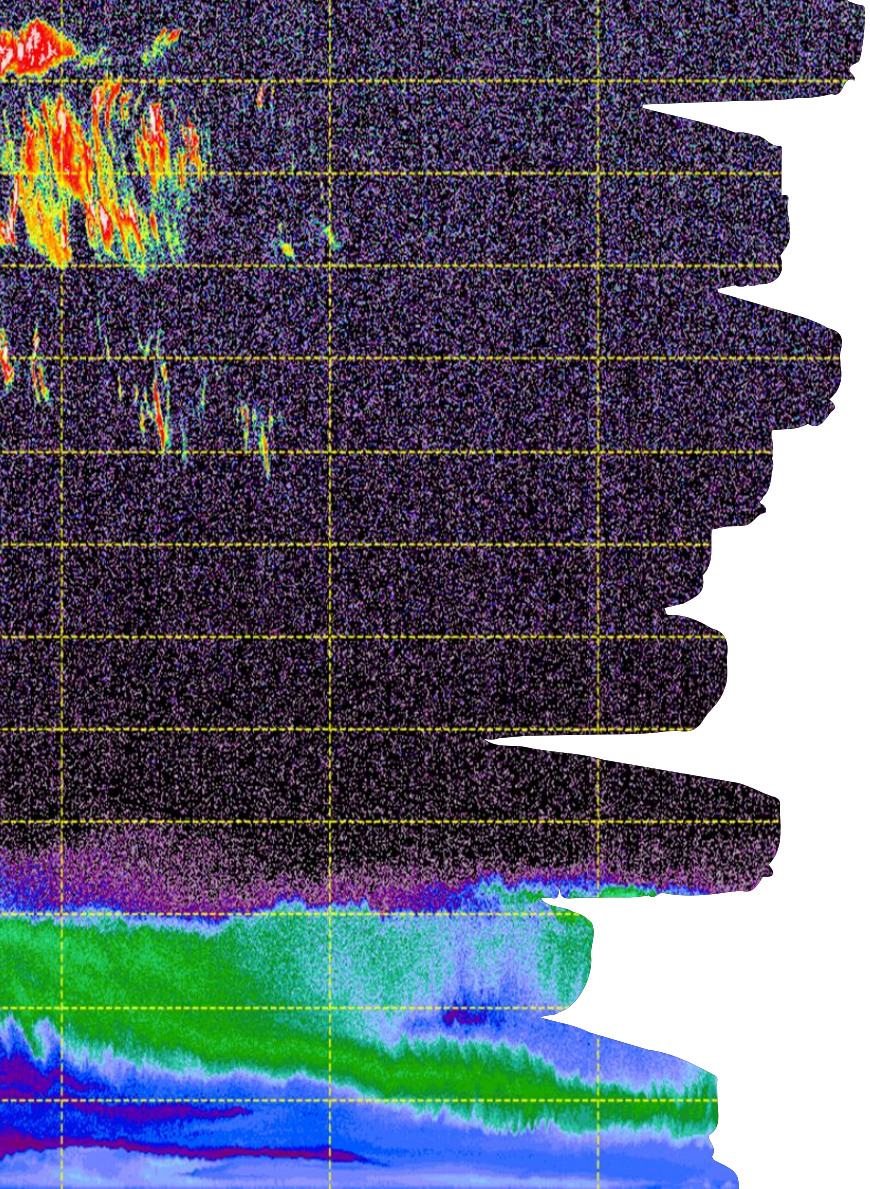

QA/QC of ALCs within ACTRIS-CARS and CCRES – Dark measurements

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ACTRIS CARS-ALC Unit

CCRES Workshop - ACTRIS Week, Heraklion, Greece, 26th October 2023

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

CARS-ALC instrument testbed

CARS-ALC-LMU

Vaisala			Campbell Scientific	Lufft	
CL31	CL51	CL61	SkyVUEPRO	CHM15kx	CHM8k
					
operation	operation	operation	operation	Gets LOM replacement	Gets LOM replacement

CARS-ALC-DWD

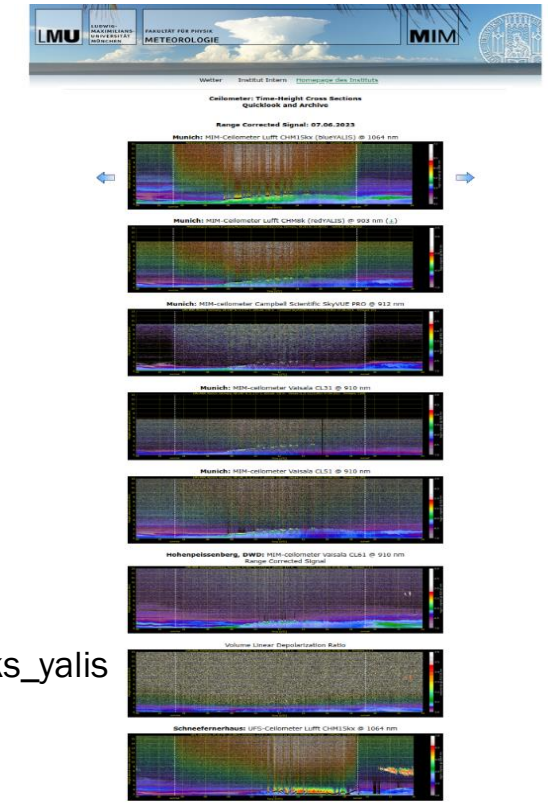
DROPLET	Lufft	
MiniMPL	CHM15k	CHM8k
		
operation	operation	operation

CARS-ALC instrument testbed

CARS-ALC unit instruments

Setup of automatic data processing and data format harmonization

- → Easier monitoring of housekeeping data
- → Easier data processing and analysis
- → Easier data and algorithm exchange with ALC community



Processing steps:

- Creation of daily files in raw output
- Conversion to Level 0/1 data format with raw2L1 tool developed within the ALC community (https://gitlab.in2p3.fr/ipsl/sirta/raw2l1)
- Creation of quicklooks for all LMU-ceilometers which are available at www.meteorologie.lmu.de/DokuWiki/doku.php?id=arbeitsgruppen:lidar:quicklooks_yalis
- First calibration measurements
  → Dark measurements

RAW2L1 tool for data harmonization

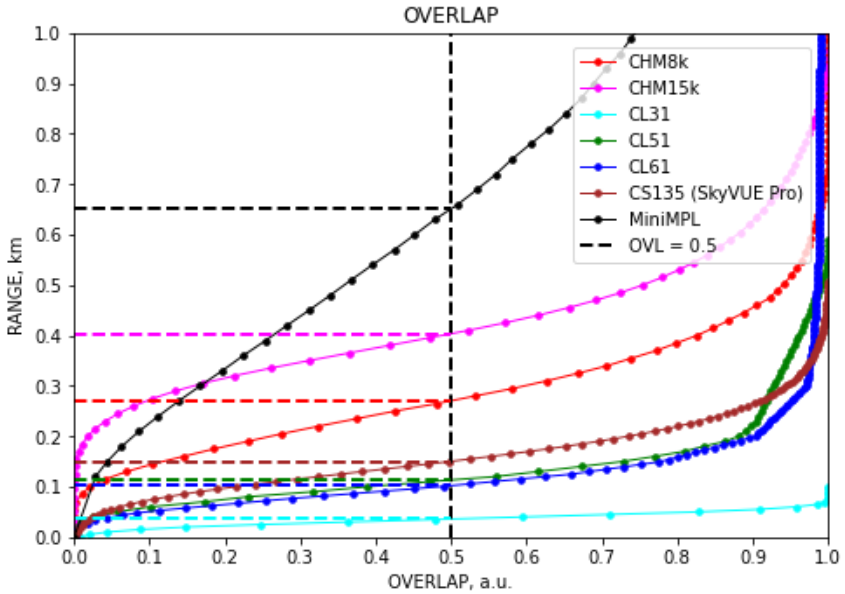
Updates provided for RAW2L – need to be implemented in main branch

CL61	**Updated reader for firmware 1.2.7:** • Monitoring and HKD data were saved in netCDF attributes in FW1.1.0 → Temporal resolution was dependent on „profiles per file“ parameter → In FW 1.2.7 as netCDF groups • New parameters available (e.g. range resolution, transmitter_enclosure_temperature, overlap function…) • Prefixed HKD variables with hkd_ and status variables with status_
CHM8k	• Wrote a reader for Lufft CHM8k since it has several differences compared to CHM15k format
CHM15k	• Updated reader for backwards compatibility down to FW 0.1109
CS135/SkyVUEPRO	• Updated an issue which prevented processing in case of alerts

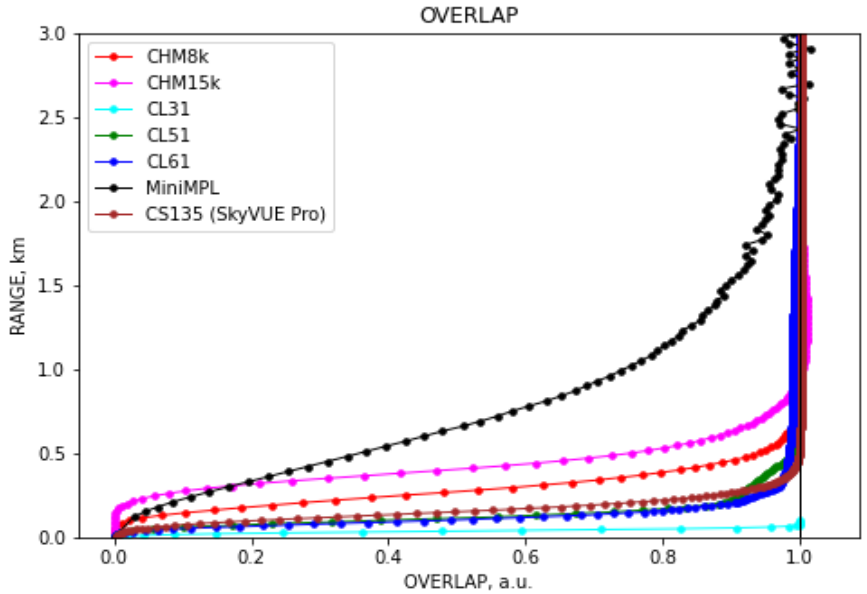
ALC Overlap functions

Overlap functions from CARS-ALC ceilometers provided by manufacturer

Zoom for 50% overlap



Full overlap



Overlap functions still have to be investigated → apply temperature correction (Hervo et al.) to existing overlap function

Dark Measurements

Regular dark measurements

- How variable are the DMs over time?
- Is a correction needed for every instrument?

Monostatic configuration	Bistatic configuration
Vaisala CL31 Vaisala CL51 Vaisala CL61 Campbell SkyVUE Pro	Lufft CHM8k Lufft CHM15k(x)
Dark measurement with optical terminatin hood from Vaisala - CL31/CL51 version - CL61 version	Dark measurement with telescope covered - e.g. cardboard

Dark Measurements

Time series of DMs

- Input: Attenuated Bsc (calibrated, r², OVL-corr.)
- Range correction removed
- Overlap function correction removed

CL61: - stable around zero above 2 km
- strong signal increase below

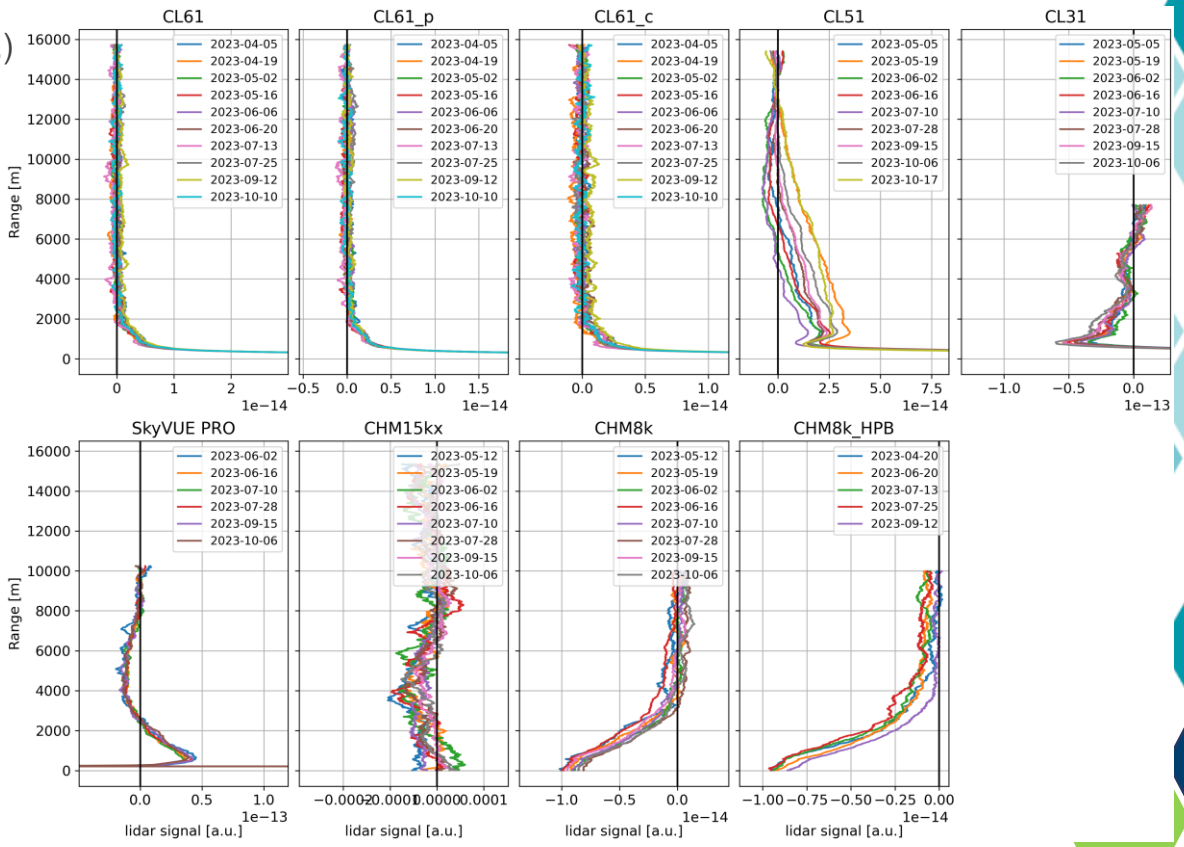
CL51: - very variable over time and height
- strong signal increase in near range

CL31: - stable over time but not height
- strong signal increase in near range

SkyVUE PRO: - stable over time but not height
- strong signal increase in NR

CHM15kx: - varying around zero → stable

CHM8k: - almost stable above 3-4 km
- signal decrease below



Dark Measurements

What is the signal strength of the DM compared to normal measurements?

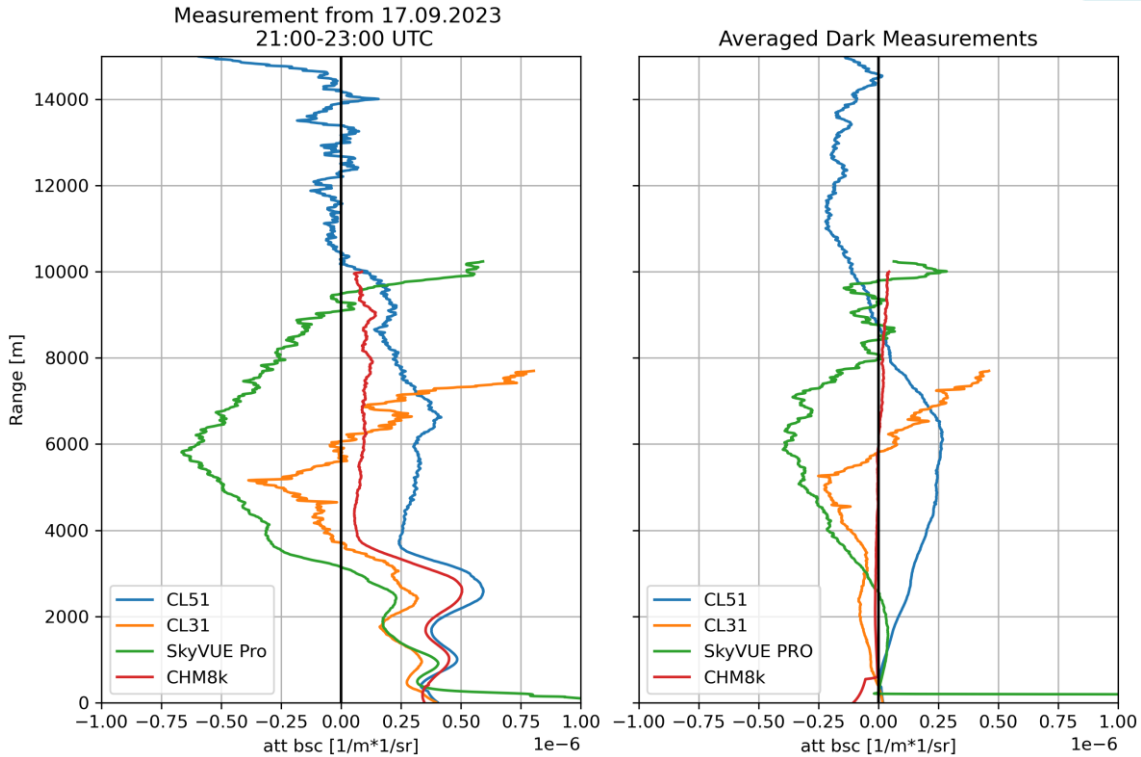
- Attenuated backscatter (no CHM15kx data)
- Overlap function correction **not** removed
- Same scale for x-axis

CL51: - signal strength of DM not negligible

CL31: - above 4 km with signal peaks in the DM
- not negligible

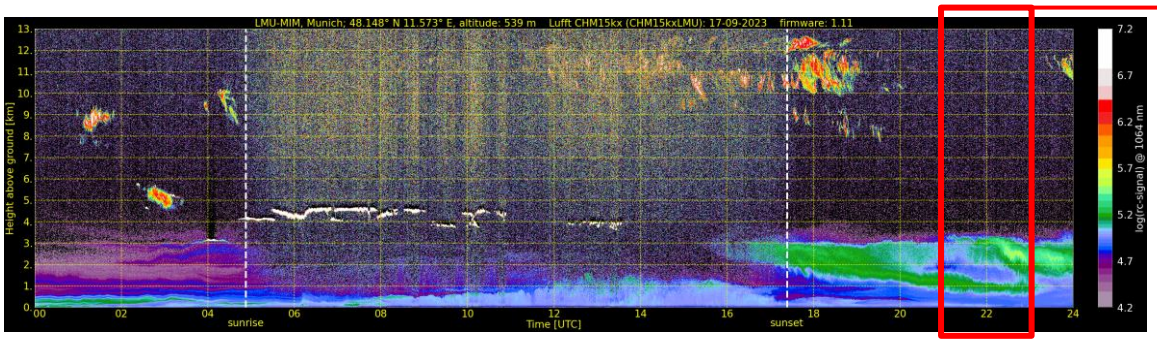
SkyVUE PRO: - strong negative peak between 3 and around 8 km
- not negligible

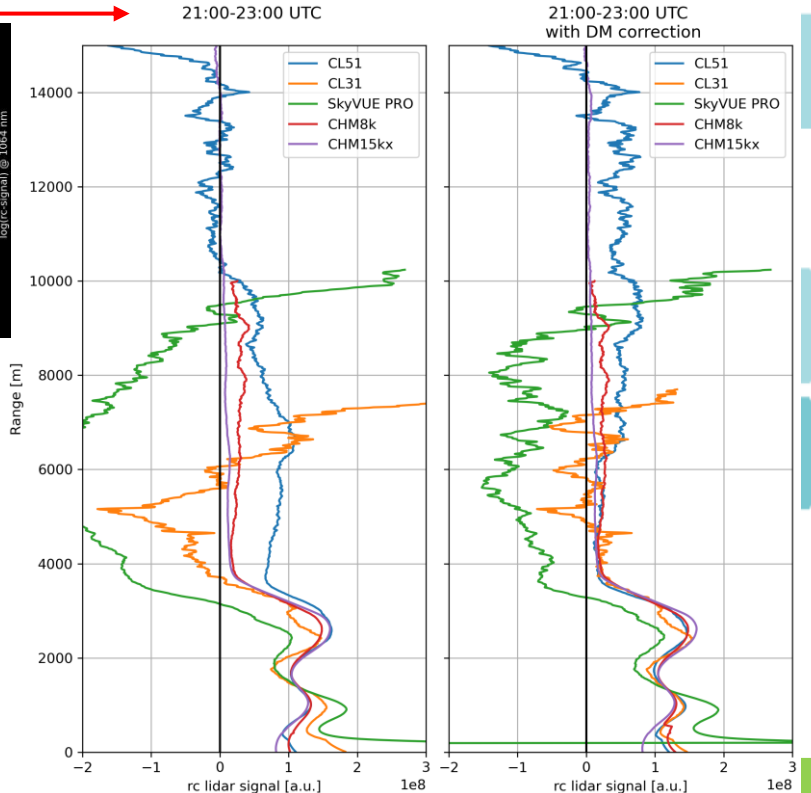
CHM8k: - DM signal strength much lower than normal profile measurement



Dark Measurements

Application of a DM correction on 17.09.2023 – with CHM15kx

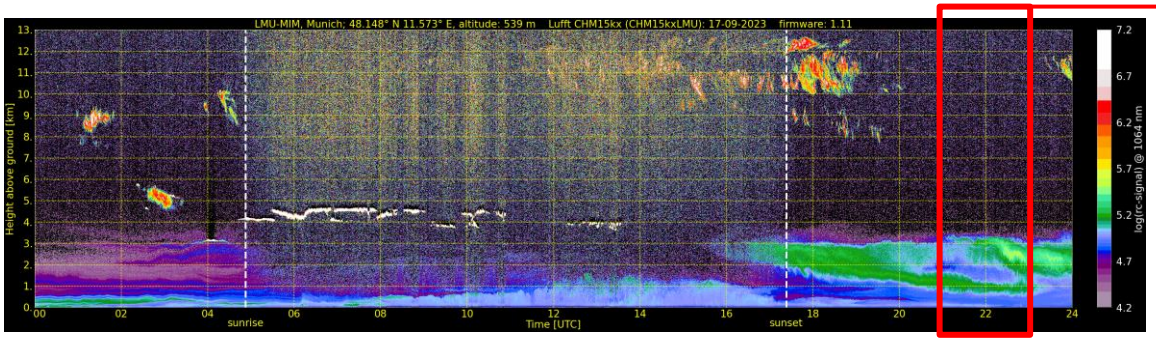


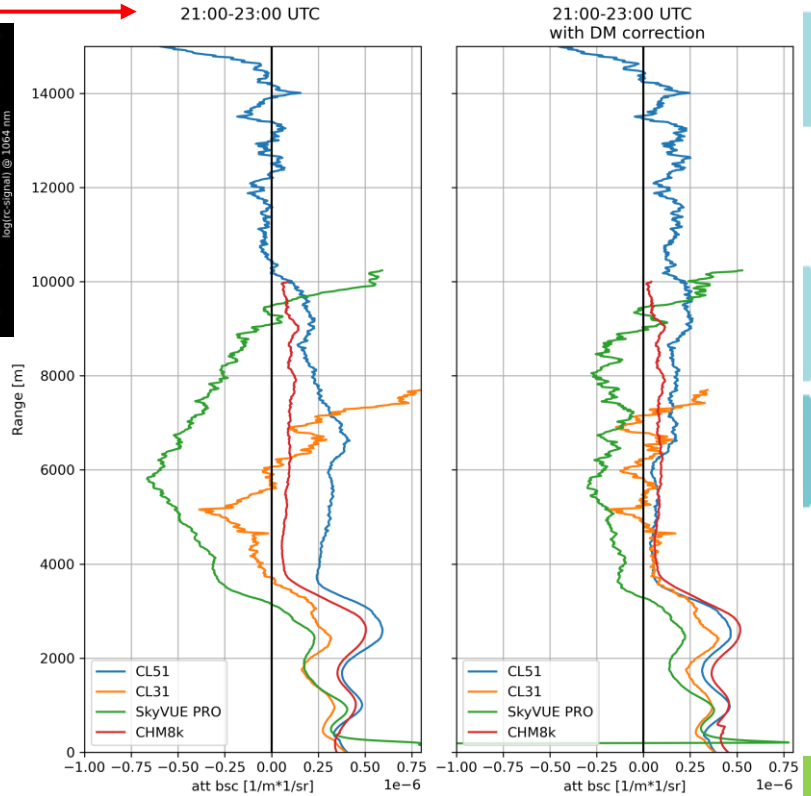


- Saharan dust layer arriving in the evening
- All lidar signals are fitted to the CHM15kx which is not calibrated → no attenuated backscatter
- Without DC-correction, larger deviations are visible for CL31, CL51 and SkyVUE PRO
- Signal improvements are achieved with the DC-correction
- However, still strong deviations for CL51 and SkyVUE PRO

Dark Measurements

Application of a DC correction on 17.09.2023 – „calibrated instruments“

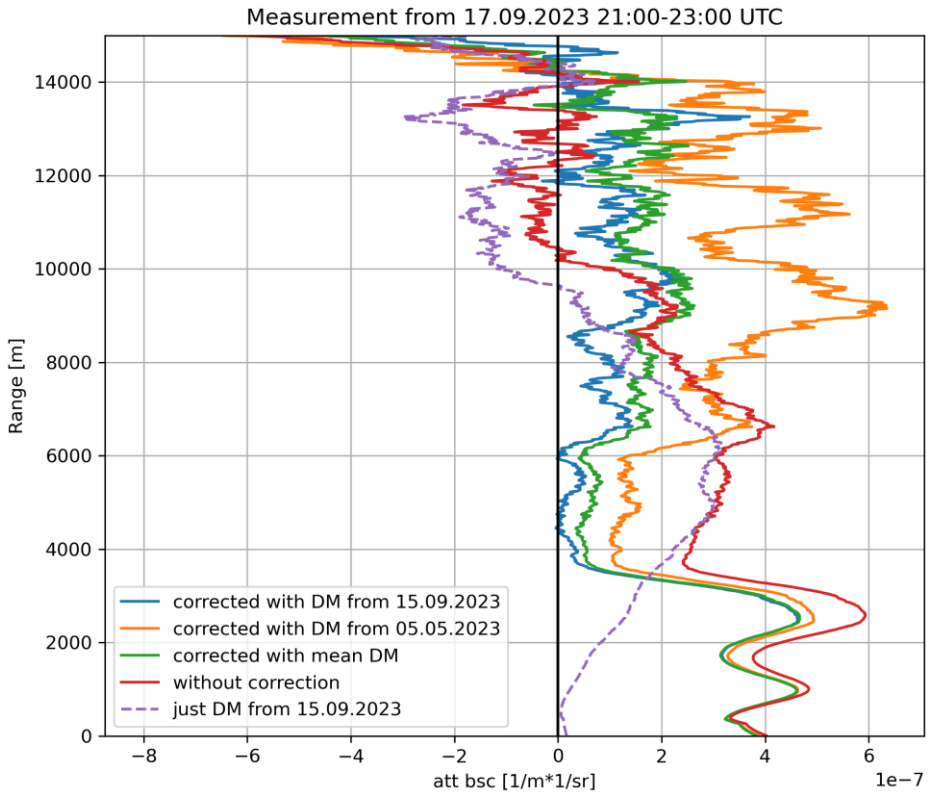




- All lidar signals are shown as attenuated backscatter with manufacturer calibration
- Without DC-correction, larger deviations are visible for CL31, CL51 and SkyVUE PRO
- Signal improvements are achieved with the DM-correction
- Still strong deviations between the instruments as shown one slide before
- Since profiles are not fitted, lidar calibration can be wrong as well

Dark Measurements

CL51 with stronger fluctuations between DMs → use most up-to-date DM?



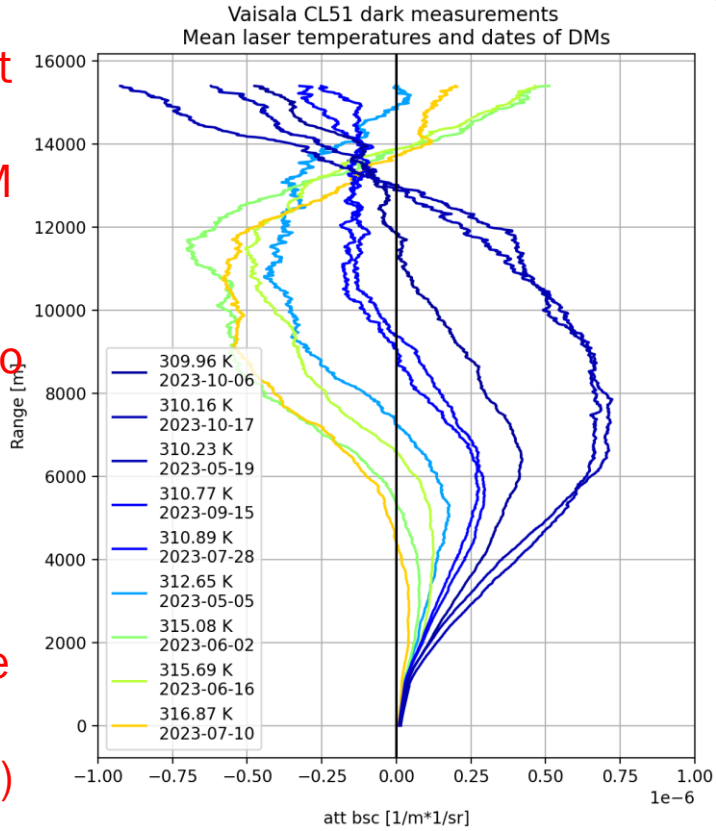
Correction not good with up-to-date DM

↓

There seems to be another dependency

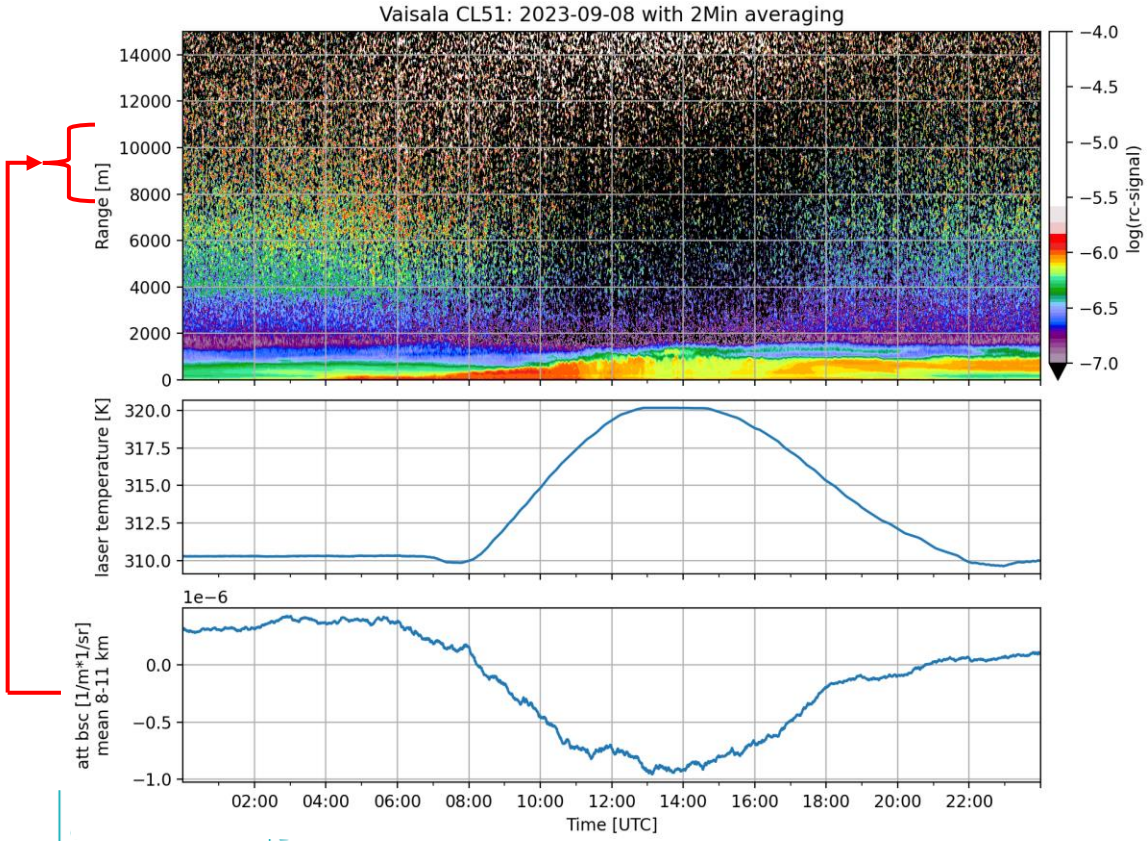
↓

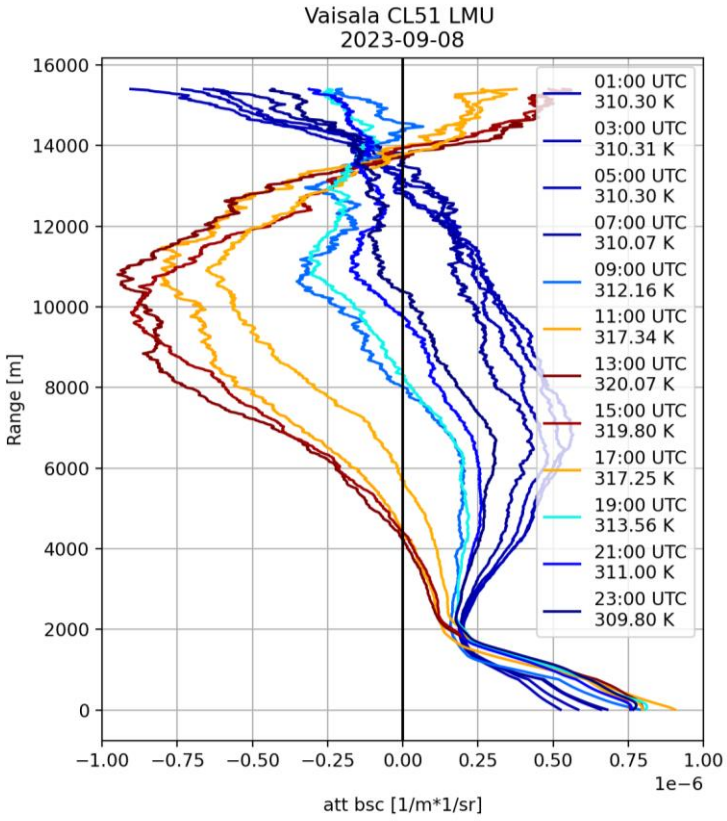
Temperature (CL51 laser temperature)



Dark Measurements

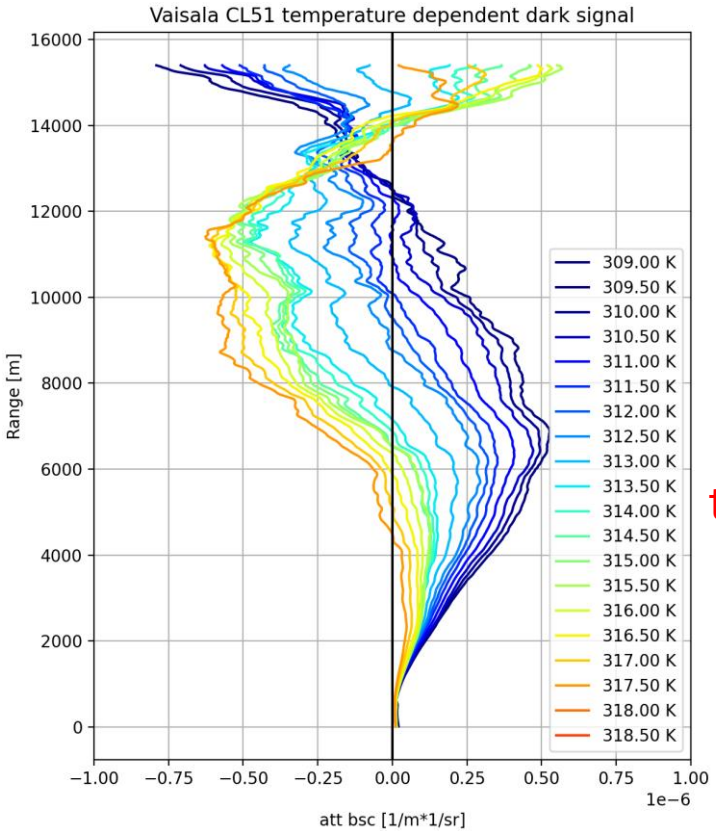
CL51 measurement on 08.09.2023: temperature ←→ atmosphere signal





Dark Measurements

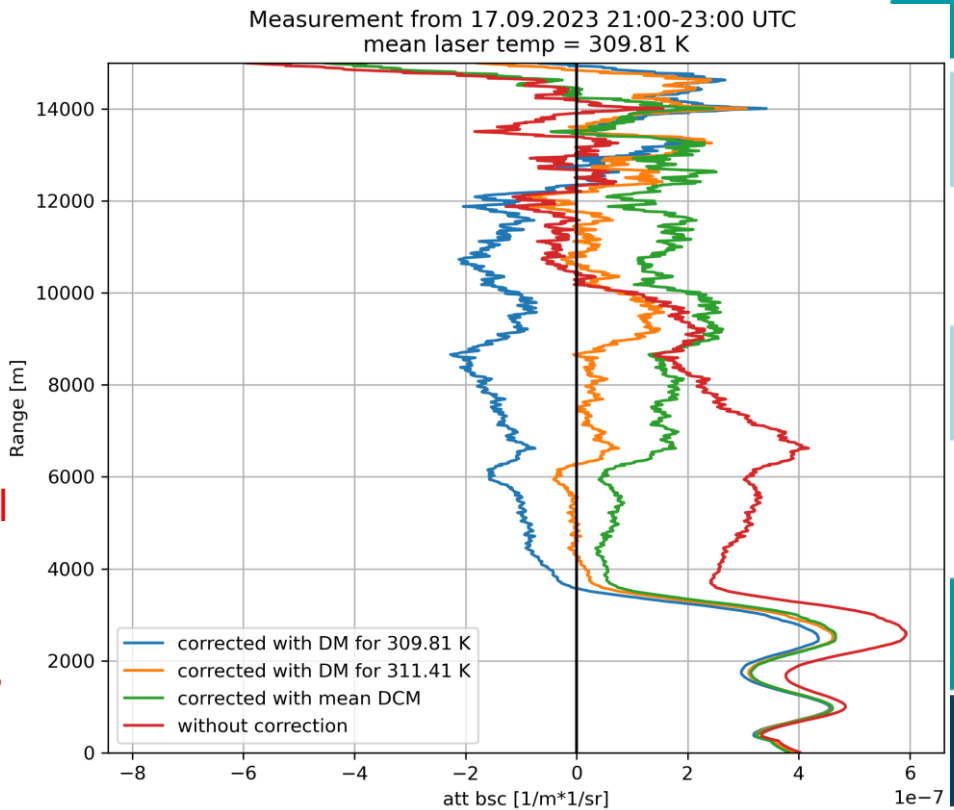
Possible DM correction for CL51 – Lookup table with profile for different T



Correction with DM depending on temperature

For the same temperature on this day not ideal

Further analysis needed!

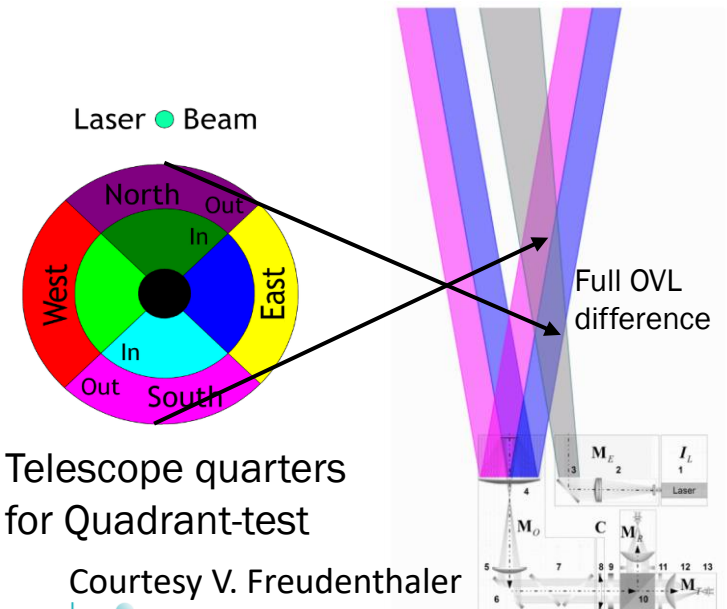


Telecover test for ALCs

First measurements with telecover test for ALCs

Experimental method to reveal distance of full overlap without the assumption of a well-mixed boundary layer

Can be applied for bi-axial ALCs (Lufft CHM15k and CHM8k)



Telescope quarters for Quadrant-test

Courtesy V. Freudenthaler

Plate for Lufft ALC

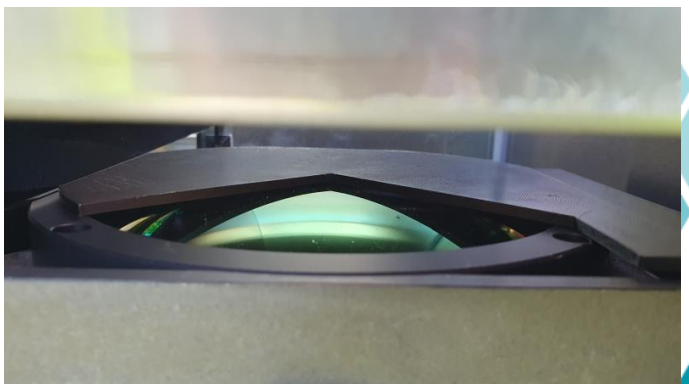


Plate on CHM8k telescope

Summary

- All instruments from CARS-ALC are now in operation
  → Gain experience on the different instruments and apply QC/QA procedures
- RAW2L1 is used to harmonize data
  → updated several readers
- Manufacturers overlap functions are currently used for processing
  → determine own overlap functions
- Regular dark measurements to check stability of the instruments
  → at the moment only the CL51 shows stronger temporal/temperature dependent variability
  → further analysis is needed to understand this effect in order to correct for it
  → important for aerosol profiling
- First tests with telecover measurements were performed but need further investigation