Western

Cloud Base Height Comparison of Co-Located Micro-pulse LiDAR and Lufft Ceilometer

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03- Atmospheric Aerosol and Cloud Properties

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CBH correlation between Co-Located MPL and CHM15k

- MPLCAN: Micro-Pulse Lidar CAnada Network
- 5 Network sites at London ON, Sherbrooke QU, Halifax NS, Eureka NU and Toronto ON (PI Debra Wunch)
- Objectives of MPLCAN included developing cross country smoke tracking, interaction and improvements in Aerosol characterization and Air Quality
- Micro-Pulse Lidar and Lufft Ceilometer operate together at an MPLCAN site partnered with MPLNET and EUMETNET's E-PROFILE
- London site has been operating since December 2020

MPLNET Home

E-PROFILE Home

MPLCAN Home

Motivations

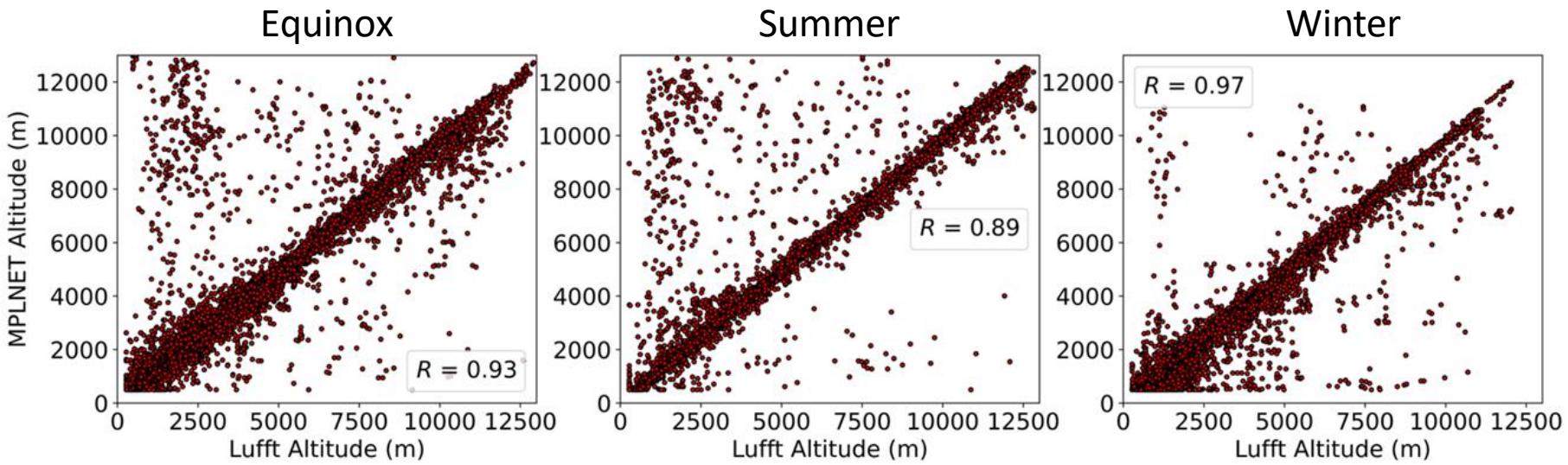
1. To accurately compare the data products of MPLNET and E-PROFILE
2. To produce a Cloud Base product that can be applied to both instruments and thus across the network
3. To minimize the difference in height detection between instruments

CBH correlation between Co-Located MPL and CHM15k

Lidar Optical System	Micro-Pulse Lidar	CHM15k
Type	Polarization	Elastic Backscatter
Wavelength	532 nm	1064 nm
Energy per Pulse	3 – 4 µJ	8 µJ
Range Resolution	5/15/30/75 m	5 m
Power Aperture Product	4.398E-05 W m^2	1.909E-05 W m^2
Mirror Diameter	80 mm	90 mm
Range	100m - 30 km	5m – 15 km
Cloud Detection	around 15 km	around 12 km

- Simultaneous operation since December 2020
- CHM 15k connected to E-PROFILE
- miniMPL data hosted on MPLNET

- Using the Cloud Base Height (CBH) Product produced by MPLNET and the Lufft (CBH), the linear regression between the two instruments has a high comparison.
- Higher comparison in low aerosol winter



Case 1: Lufft CHM15k Cloud Base Altitude vs MPLNET V3 Cloud Base Altitude. Equinox (Spring, Autumn), Summer and Winter 2021-2022

CBH correlation between Co-Located MPL and CHM15k

- Utilizes profiles in five-minute intervals
- If $\frac{dR(z)}{dz} > 0$, there is a minimum 60 m increasing gradient, and the value of $\beta > a_{thres}$, z value is marked as Cloud Base.
- If profile is clear, and previous profile has a cloud, profile is rechecked with $\beta > 0.5\ a_{thres}$
- Based on MPLNET V2 [1]

$$R(z) = \frac{\beta(z)T^2(z)}{\beta_{mol}(z)T_{mol}^2(z)} \qquad (1)$$

$$a_{thres} = C\bar{\beta} \qquad (2)$$

$\beta(z) = Normalized\ Backscatter$
$T^2(z) = Two - way\ Atmospheric\ Transmission$
$\bar{\beta} = Spacial\ Average\ of\ Normalized\ Backscatter$
$a_{thres} = Threshold$
$R(z) = attenuated\ backscatter\ ratio$
$C = empirical\ value$

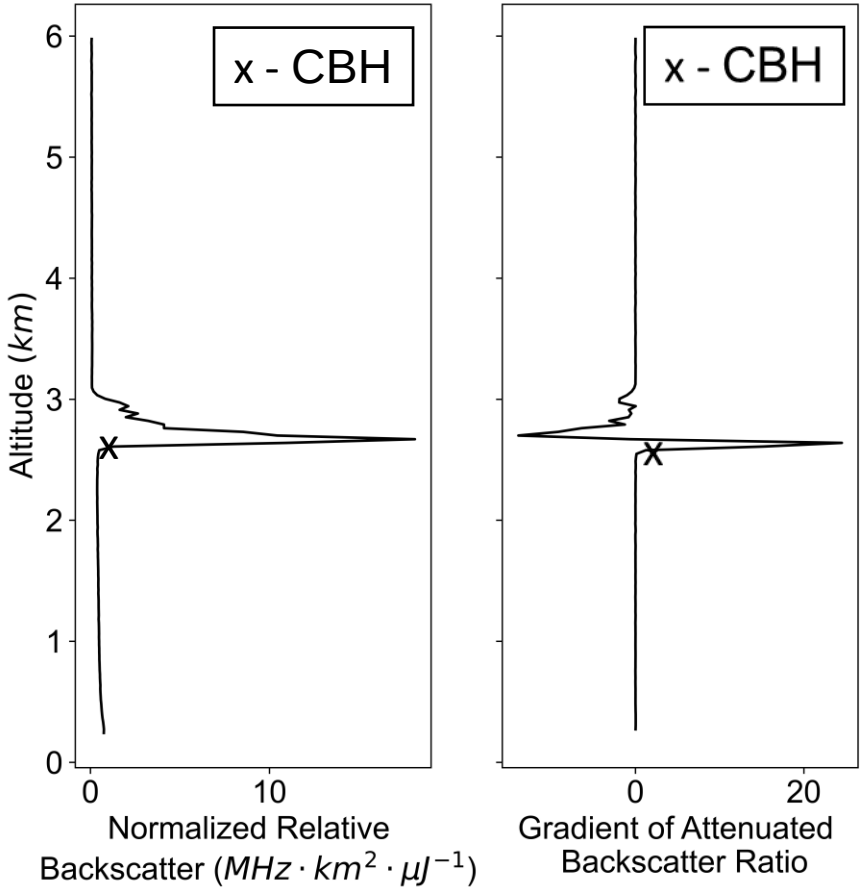
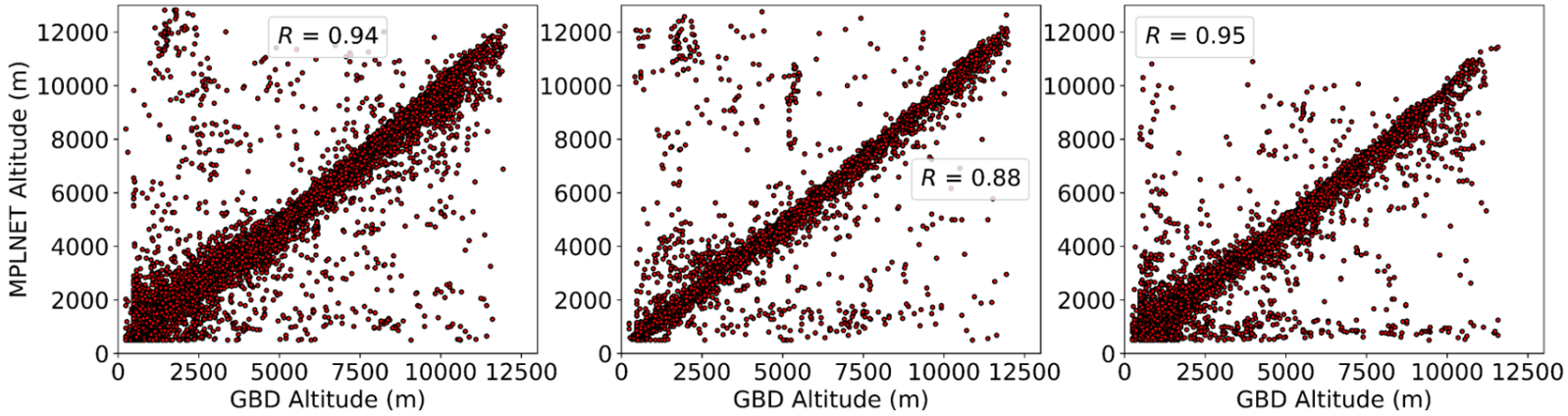


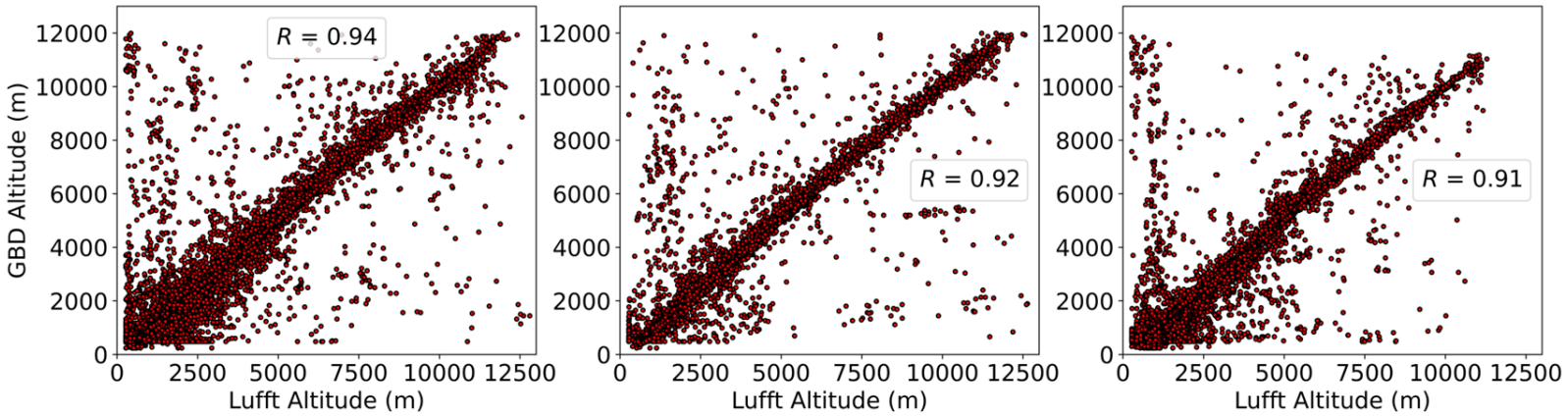
Figure: Example cloud located between 2 and 3 km with marked cloud base observation.

[1] Lewis, J., Campbell, J., Welton, E., Stewart, S., Haftings, P.: Overview of MPLNET Version 3 Cloud Detection. Journal of Atmospheric and Oceanic Technology **33**, 2113--2134 (2016)

CBH correlation between Co-Located MPL and CHM15k



Case 2: Gradient Based Detection (applied on MPL data) vs MPLNET Cloud Base Height. Equinox (Spring, Autumn), Summer and Winter 2021-2022

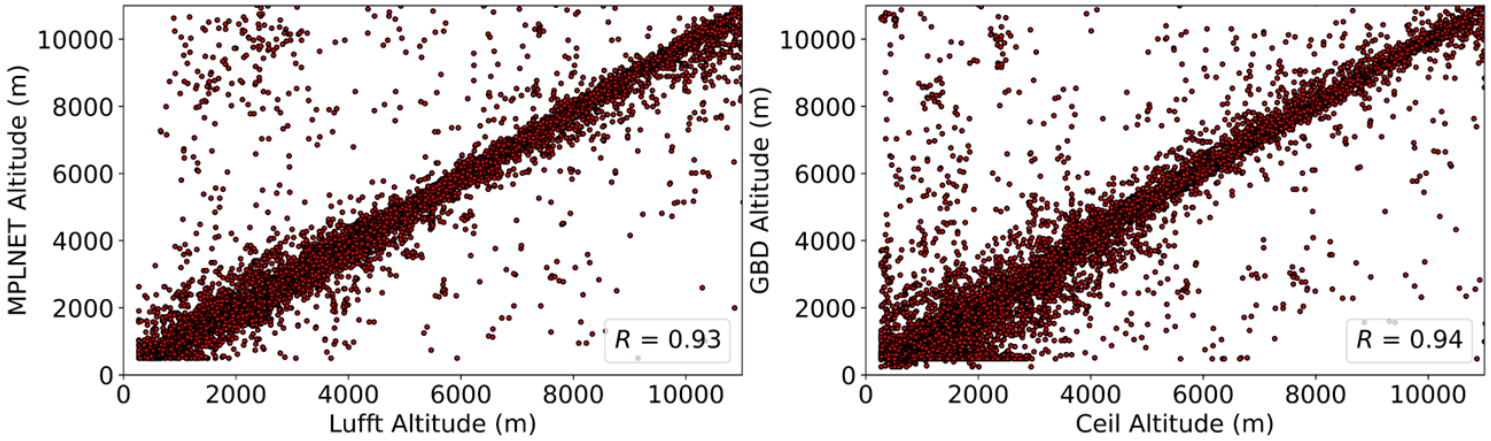


Case 3: Gradient Based Detection (applied on MPL data) vs Lufft Cloud Base Height. Equinox (Spring, Autumn), Summer and Winter 2021-2022

CBH correlation between Co-Located MPL and CHM15k

Summary

- Initial network comparison is overall good
- Algorithm has comparable statistical values, and can be applied to instruments in both networks
- Open source and will be available on GitHub



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