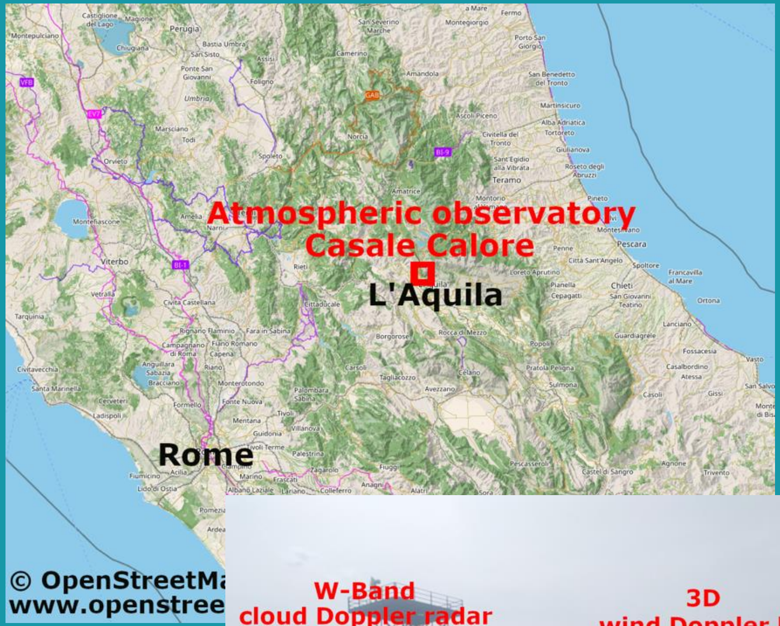
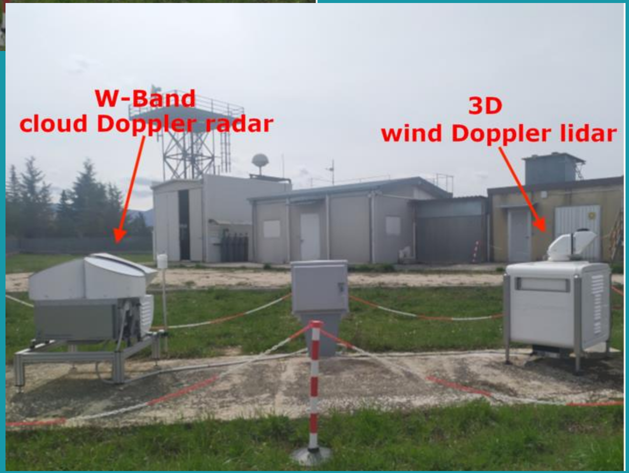


L’Aquila NF (AQ-NF)

CETEMPS

DSFC
Dipartimento
di Scienze Fisiche
e Chimiche

ISAC
National Research Council of Italy
Institute of Atmospheric Sciences
and Climate



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Analysis of in-cloud vertical air velocity from W-band radar

Opportunity for a routine product?

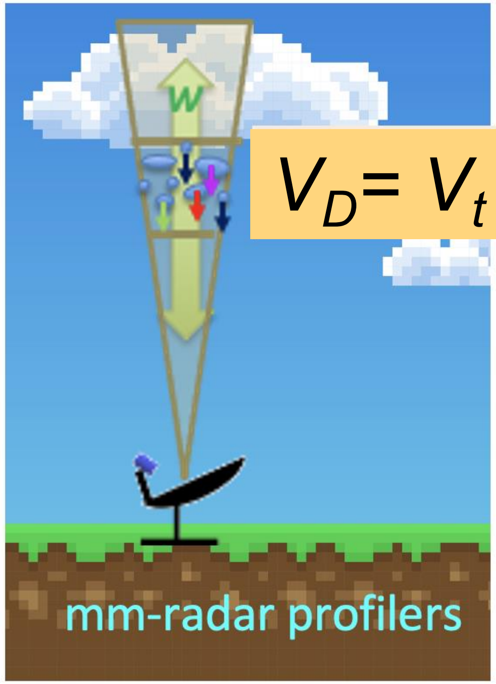
Mario Montopoli and Saverio Di Fabio
and support from AQ-NF team
(mario.montopoli@cnr.it)

CCRES/CLU Autumn Workshop, Evora, 22 October 2025

GOAL

- **Disentangle terminal velocity (V_t) from vertical air velocity (w) in rain regimes**

$$V_D = V_t + w$$

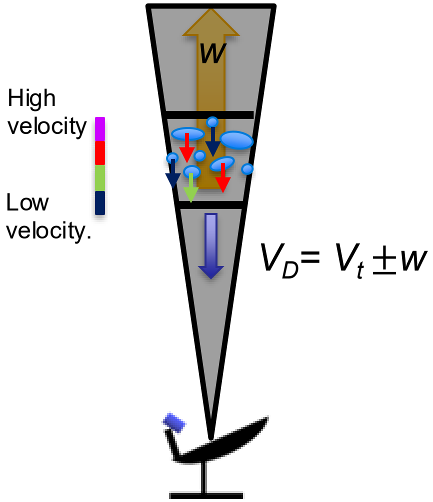


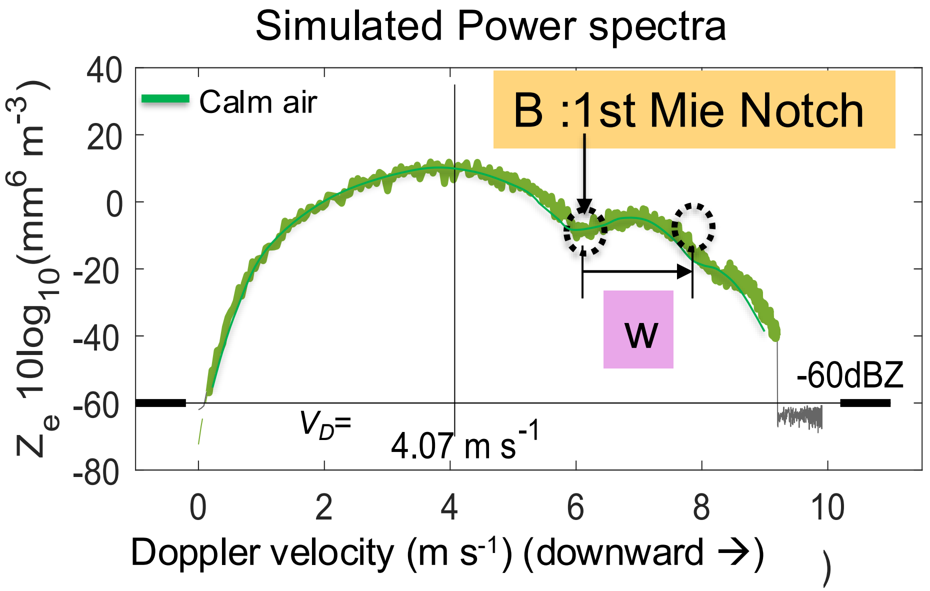
$w=?$

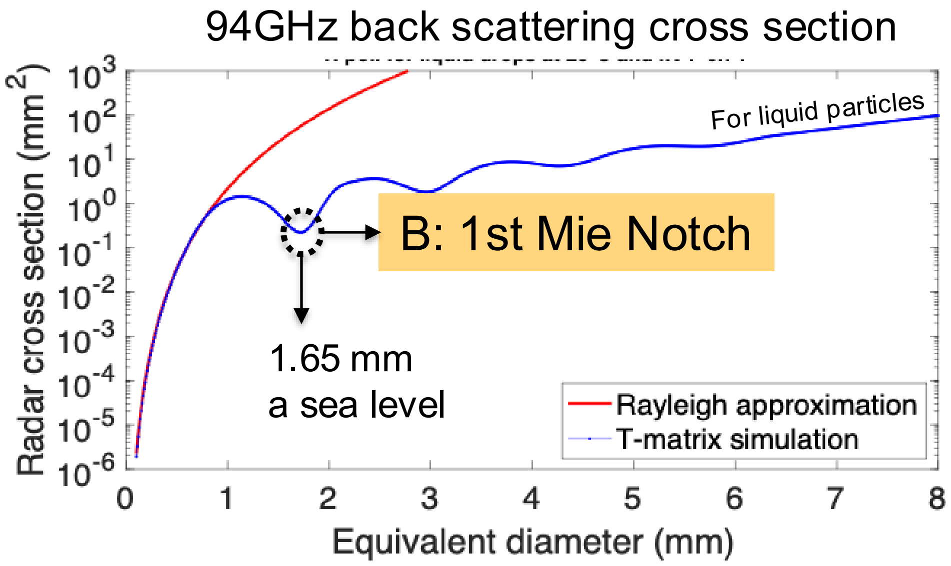
METHODS

- **Use Mie Notch technique (*Kollias et al., 2002*) to directly estimated *w* from 94GHz vertically pointing radar**

- **Tune $V_t = a Z^b$ using $V_t = V_D - w$ with V_D, Z measured by the 94GHz radar**

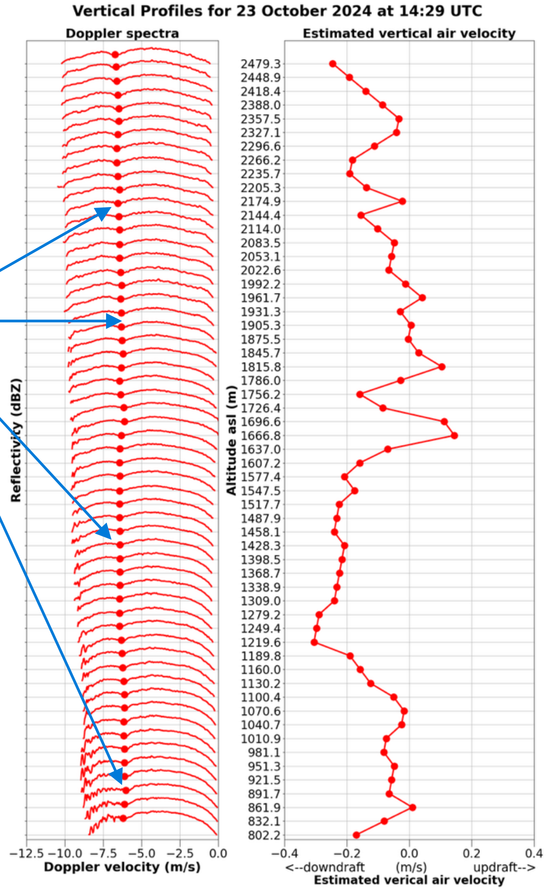


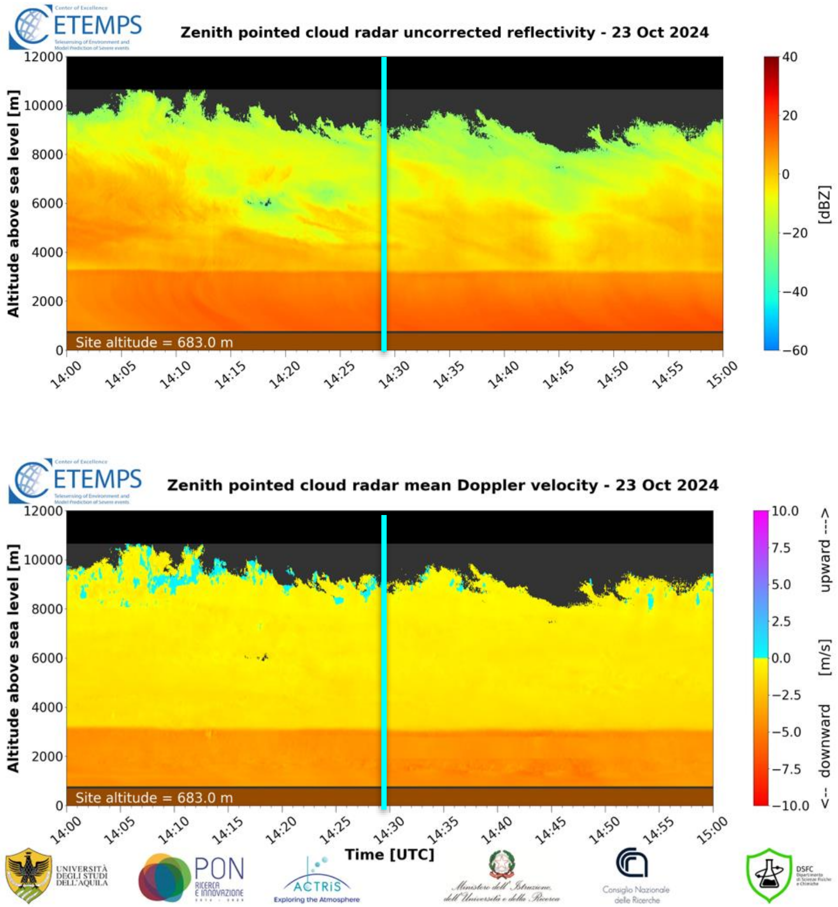




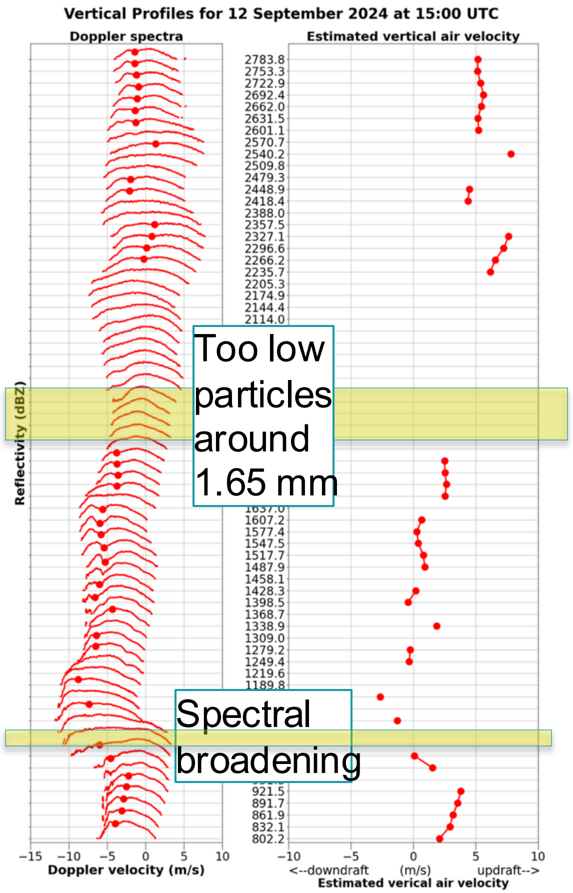
Vertical air estimation: a stratiform example

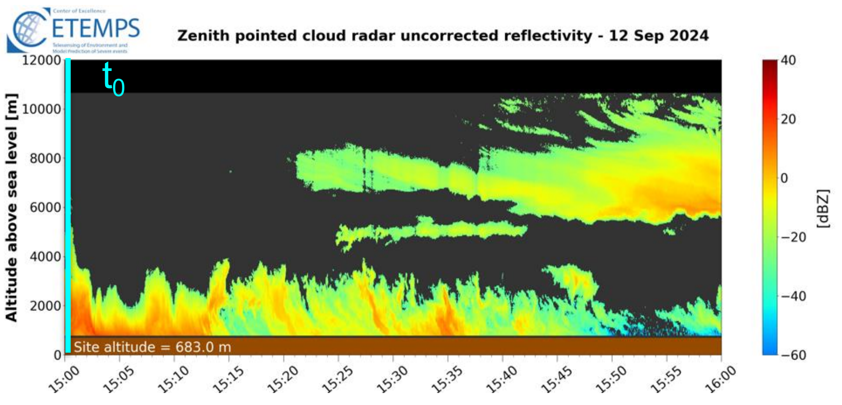
Mie Notch

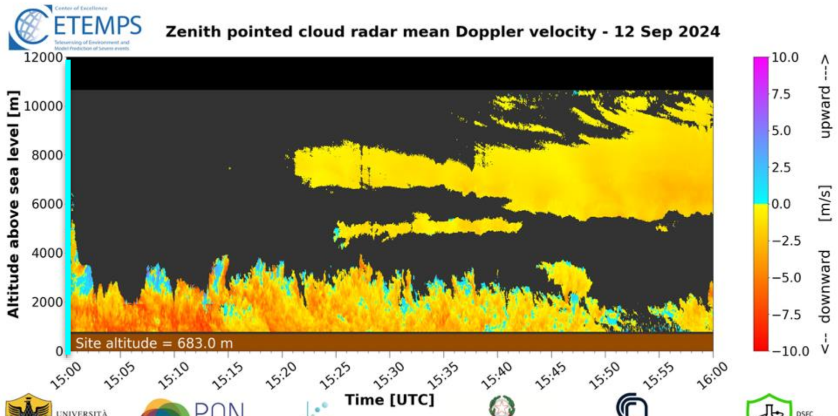




Vertical air estimation: a convective example







Mie notch is not always detectable, so vertical air profile may result incomplete especially in convection

Statistic of vertical air wind detectability

- **Initial 373831 total number of range bins processed (the dataset is mostly stratiform!!!)**
- **After a screening procedure on each power spectrum we got:**
- **111751 (29.9%) of range bins for which we were able to detect Mie Notch (i.e. vertical air, *w*)**
- **Thus, we used Mie notch *w* to obtain a target $V_t = V_D - w$ and tune a $\widehat{V_t} = a\,Z^{\,b}$ relationship to achieve an indirect estimate of vertical air as $w = V_D - \widehat{V_t}$ which is expected to be more likely available along the profie.**

see next slide

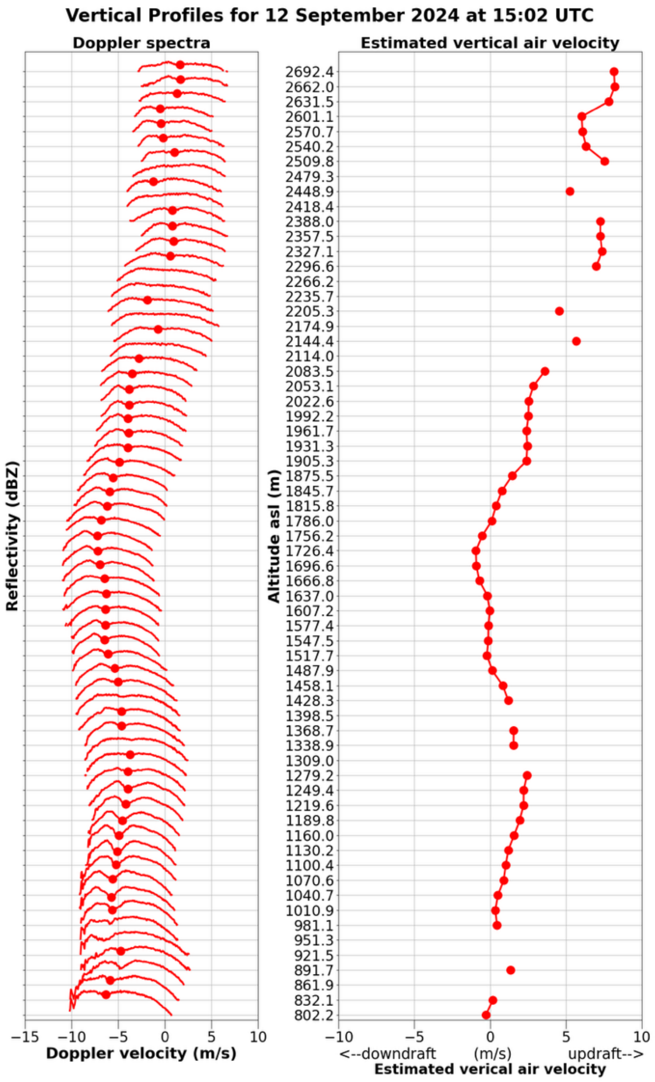
Example of of vertical air wind profiles

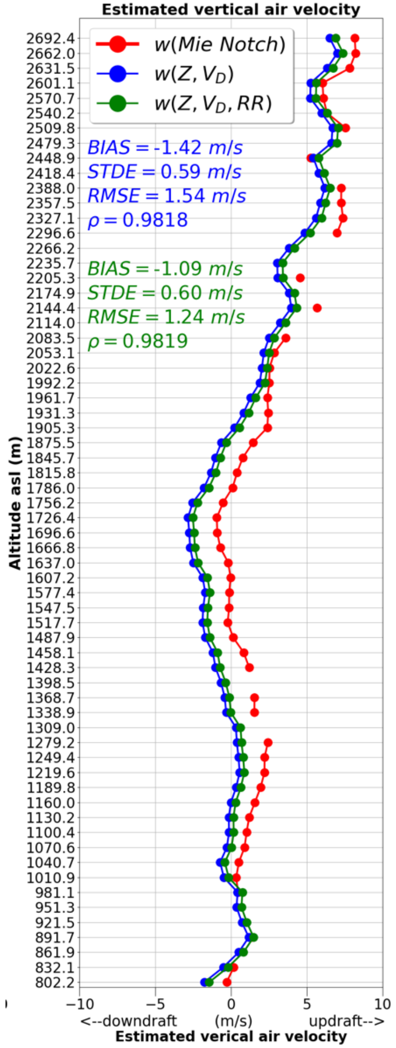
$w(MieNotch)$

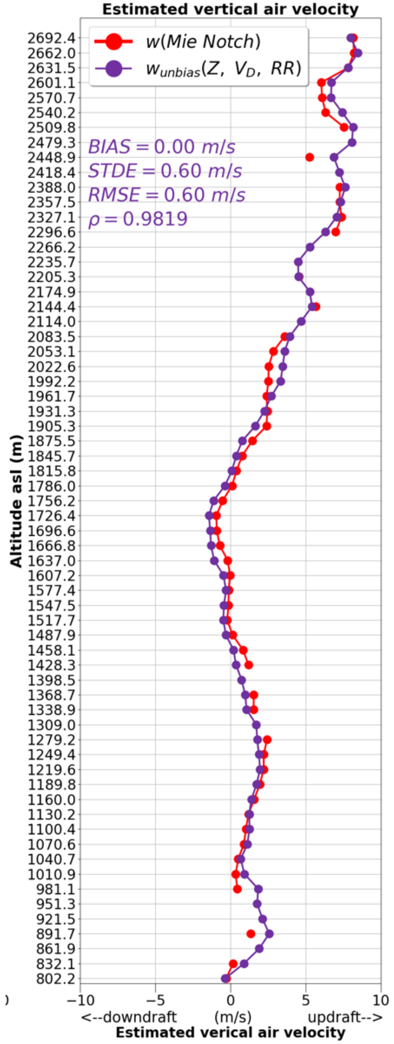
$w(Z,V_D,RR) = V_D - \underbrace{a(RR)Z^{b(RR)}}_{\widehat{V}_t}$

$w_{unbiased}(Z,V_D,RR) = w - bias$

$bias = \langle w(Z,V_D,RR)\rangle_h - \langle w(MieNotch)\rangle_h$







Vertical air wind from Z, V_D, RR

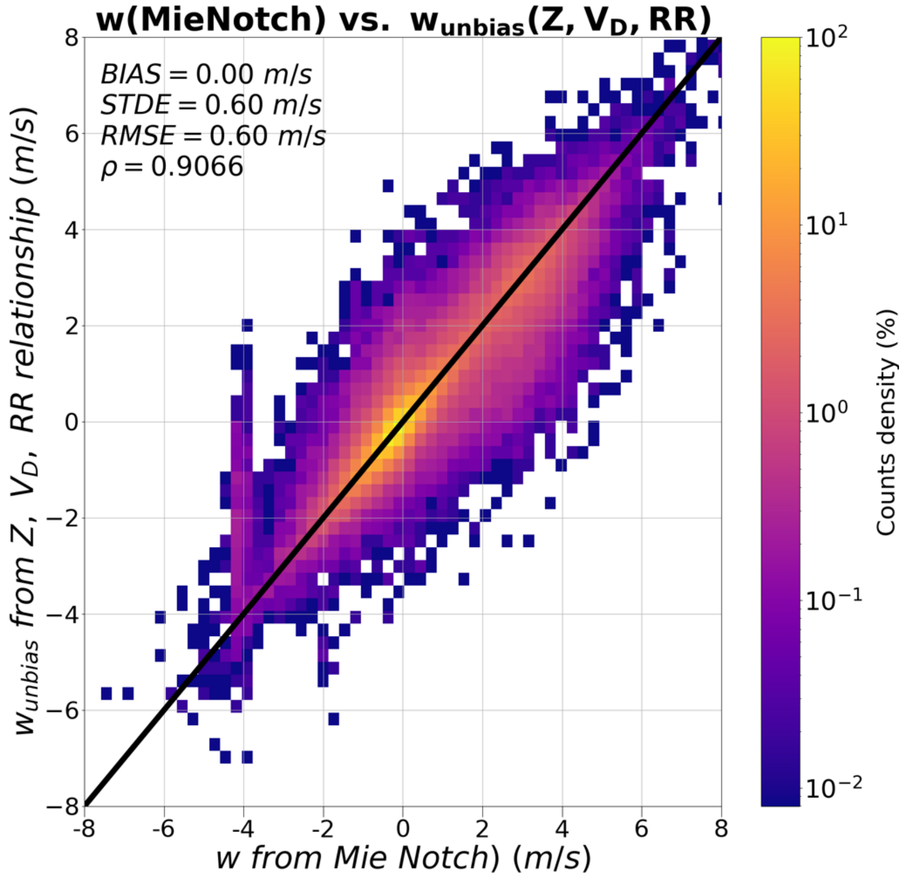
- **When we compare $w(MieNotch)$ and $w_{unbiased}\ (Z, V_D, RR)$ we obtain and excellent agreement.**
- **However, the tune of $w_{unbiased}\ (Z, V_D, RR)$ is performed on the same dataset used for testing. So a more fair comparison should be extended to an independent dataset**

$$\widehat{V_t} = a(RR)Z^{b(RR)}$$

$$w(Z, V_D, RR) = V_D - \widehat{V_t}$$

$$bias = \langle w(Z, V_D, RR)\rangle_h - \langle w(MieNotch)\rangle_h$$

$$w_{unbiased}\ (Z, V_D, RR) = w - bias$$



RR: rain rate at the ground from LPM disdrometer
$\langle\cdot\rangle_h$: average operator along the profiles
Z: bias corrected equivalent reflectivity factor
V_D : vertical Doppler velocity

Future steps

- **Extends dataset**
- **Path attenuation compensation**

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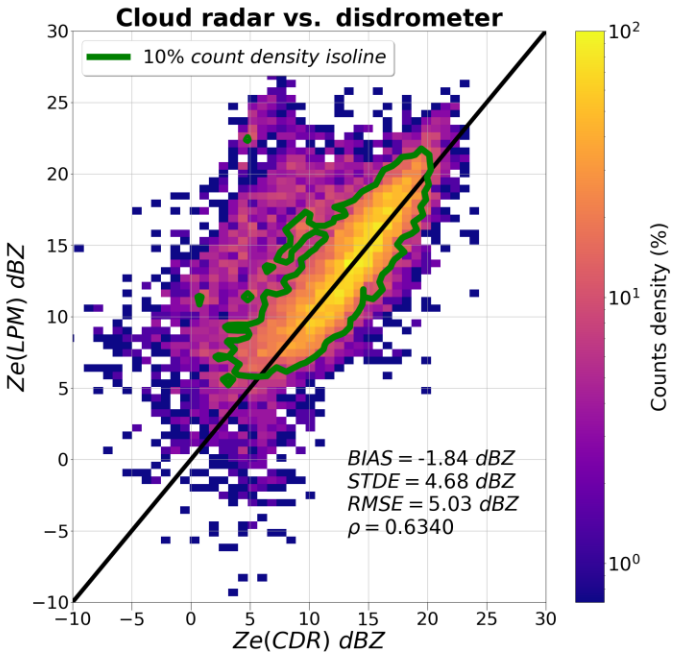
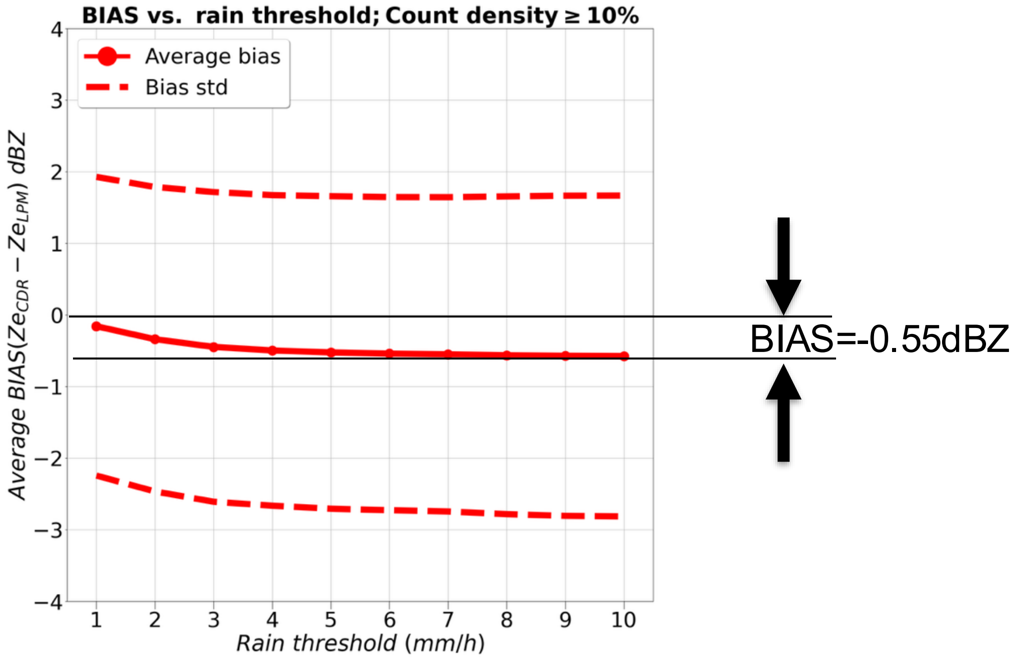
Thank you !

backup

RADAR CALIBRATION

- Z_e radar (CDR) vs Z_e disdrometer (LPM) 373831 total number of range bins collected
- 1st bin at 12o m a.g.l.
- At least 5 min of continuous rain periods are selected within 0.1<R<300 mm/h
- Scatter density larger than 10% is used to exclude tails of the Z_e distribution
- Rain rates from LPM is varied between 0.1 and 10 mm/h to look at the regimes where BIAS stabilise.





Z_e radar (CDR) is compensated by 0.55 dBZ of bias.