

Use of ACTRIS/EARLINET correlative observations for the validations of ATLID's AER and EBD L2 products in cirrus clouds (EVID14)

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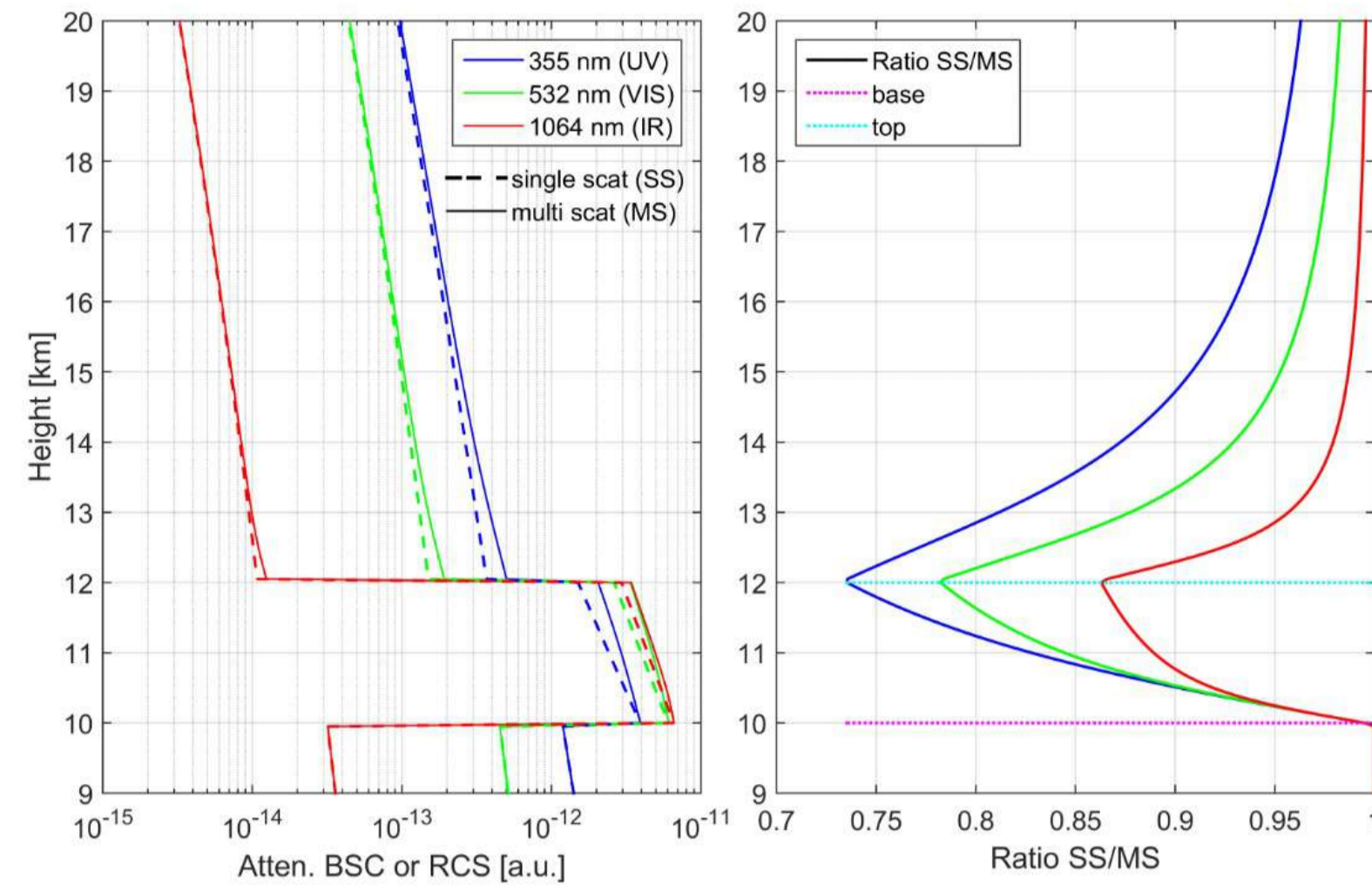
Introduction

The validation of ATLID's L2 products for cirrus clouds using ground-based lidar observations can be challenging for a number of reasons: The spatial and temporal inhomogeneity of the cloud field, even for cirrus, often limits the conclusions from a one-to-one comparison with correlative observations; the frequency of occurrence of cirrus outside tropical regions can be low; independent retrievals of extinction and backscatter profiles using the ground-based Raman technique are limited to nighttime observations; among others. While the correlative observations at the many ACTRIS/EARLINET stations can increase the odds of finding suitable cases for cirrus validation, the provided ground-based extinction and

backscatter profiles centrally processed by the Single Calculus Chain (SCC) do not include any treatment of the multiple-scattering (MS) effects in cirrus clouds, which can lead to large biases. In this work, we are extending the MS treatment to ground-based observation at other ACTRIS stations. With some compromise in accuracy, an initial MS correction can be applied directly to the ground-based extinction profiles available via EVDC. With the increased number of validation cases, we are further investigating the level of significance of the biases found so far at the Cabauw site.

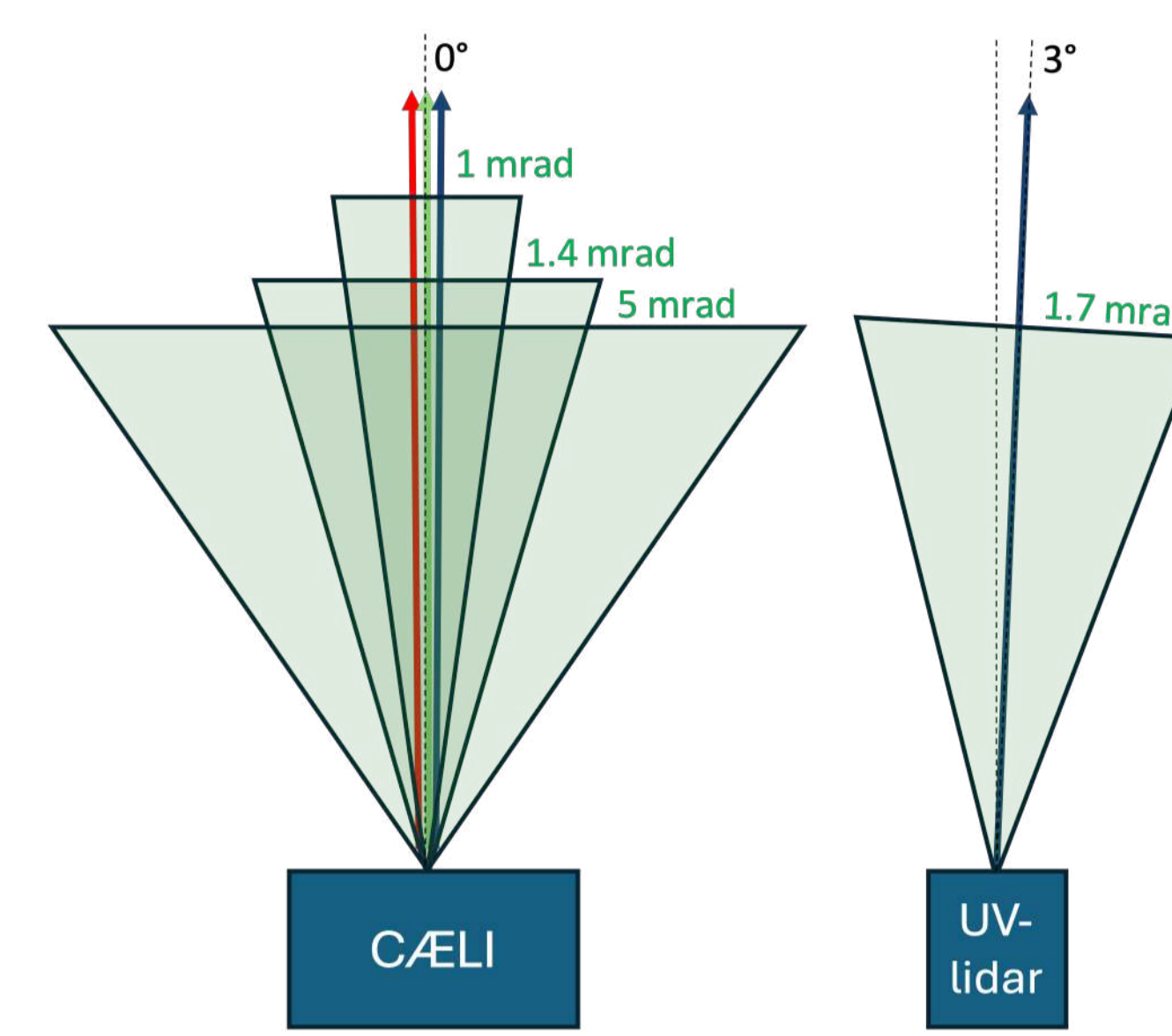
Multiple Scattering In Cirrus

- Cirrus measurements are highly influenced by multiple scattering effects
- Uncorrected MS leads to a considerable underestimation of the extinction coefficient and the extinction-to-backscatter (lidar-) ratio (LR)
- While ATLID's products are corrected for MS effects, the ACTRIS Retrievals do not include multiple-scattering correction

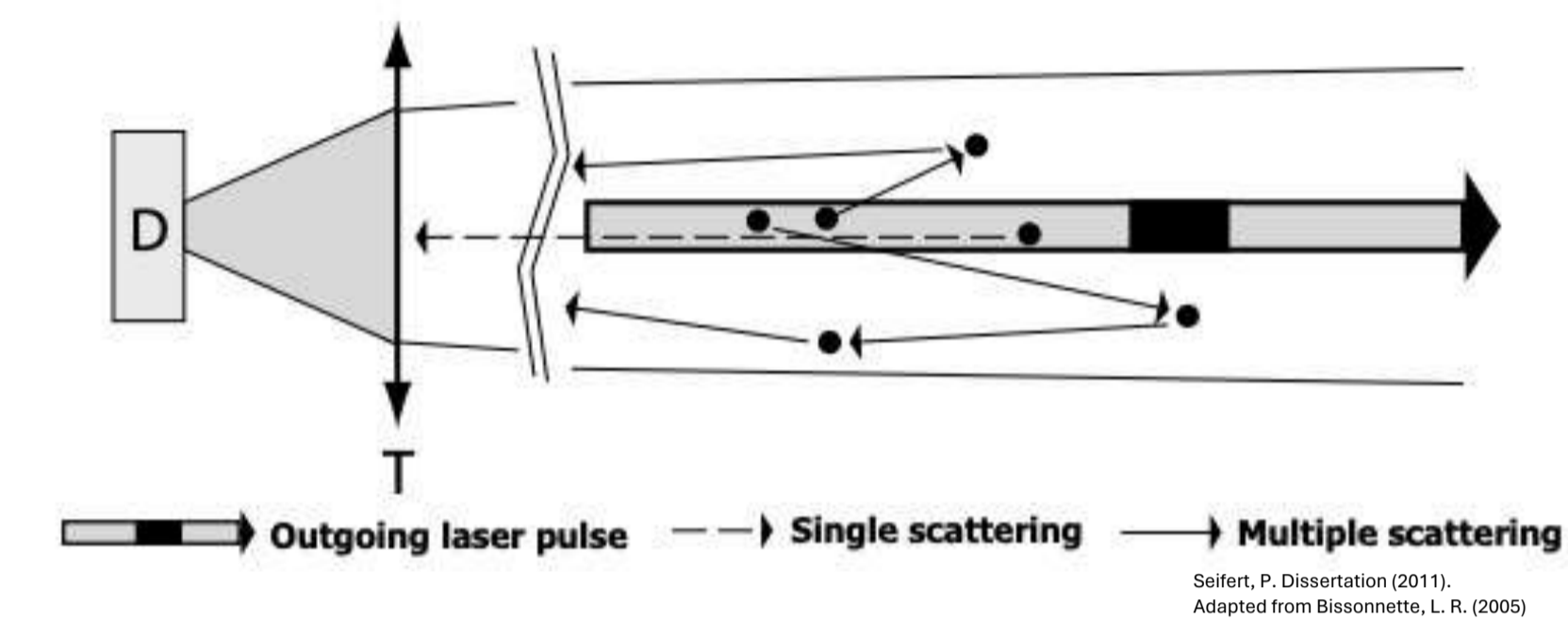


Left: Simulated lidar signal with (black) and without (pink) the effects of MS using Hogan's model (2006) for a lidar system (355nm) with laser divergence of 0.2 mrad and RFOV of 1.0 mrad. Cirrus with ext. coeff. of 0.3 km^{-1} (COD 0.6), LR of 30 sr and effective radius of 30 μm . Right: Ratio of single to multiple scattered signal.

Cabauw ACTRIS/EARLINET systems: 4 FOVs

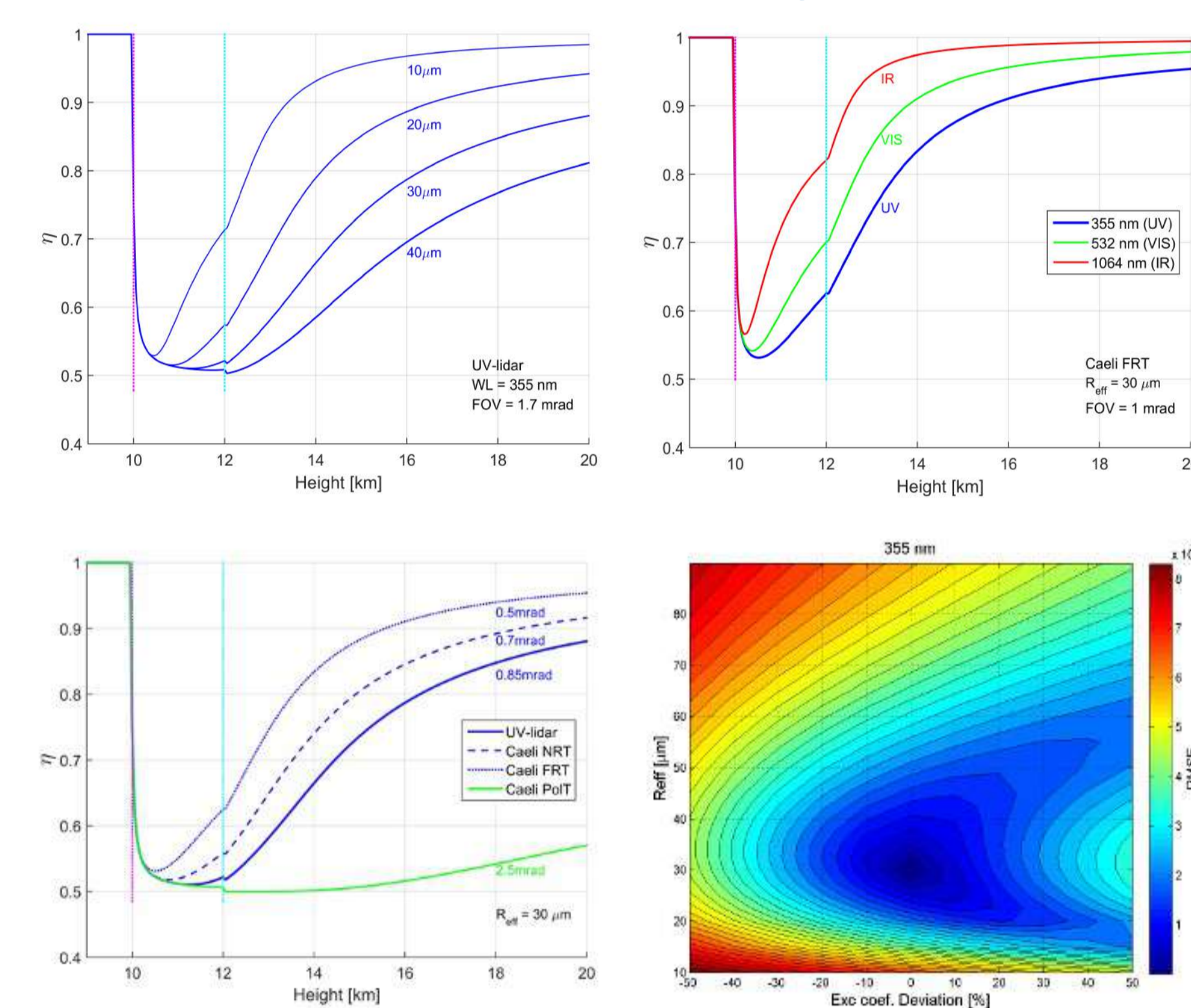


- Caeli: $3\beta + 2\alpha + \delta_{532}$ above $\sim 800 \text{ m}$
- Near Range Telescope (NRT): FOV = 1.4 mrad fw
- Far Range Telescope (FRT): FOV = 1.0 mrad fw
- Polarization Telescope (PoIT): FOV = 5 mrad fw
- Laser divergence = 0.2 mrad fw
- UV-lidar: $\beta_{355}, \alpha_{355}, \delta_{355}$ above $\sim 300 \text{ m}$ (24/7)
- Single Telescope (UVLT): FOV = 1.7 mrad fw
- Laser divergence: 0.02 mrad fw



Multiple Scattering Sensitivity

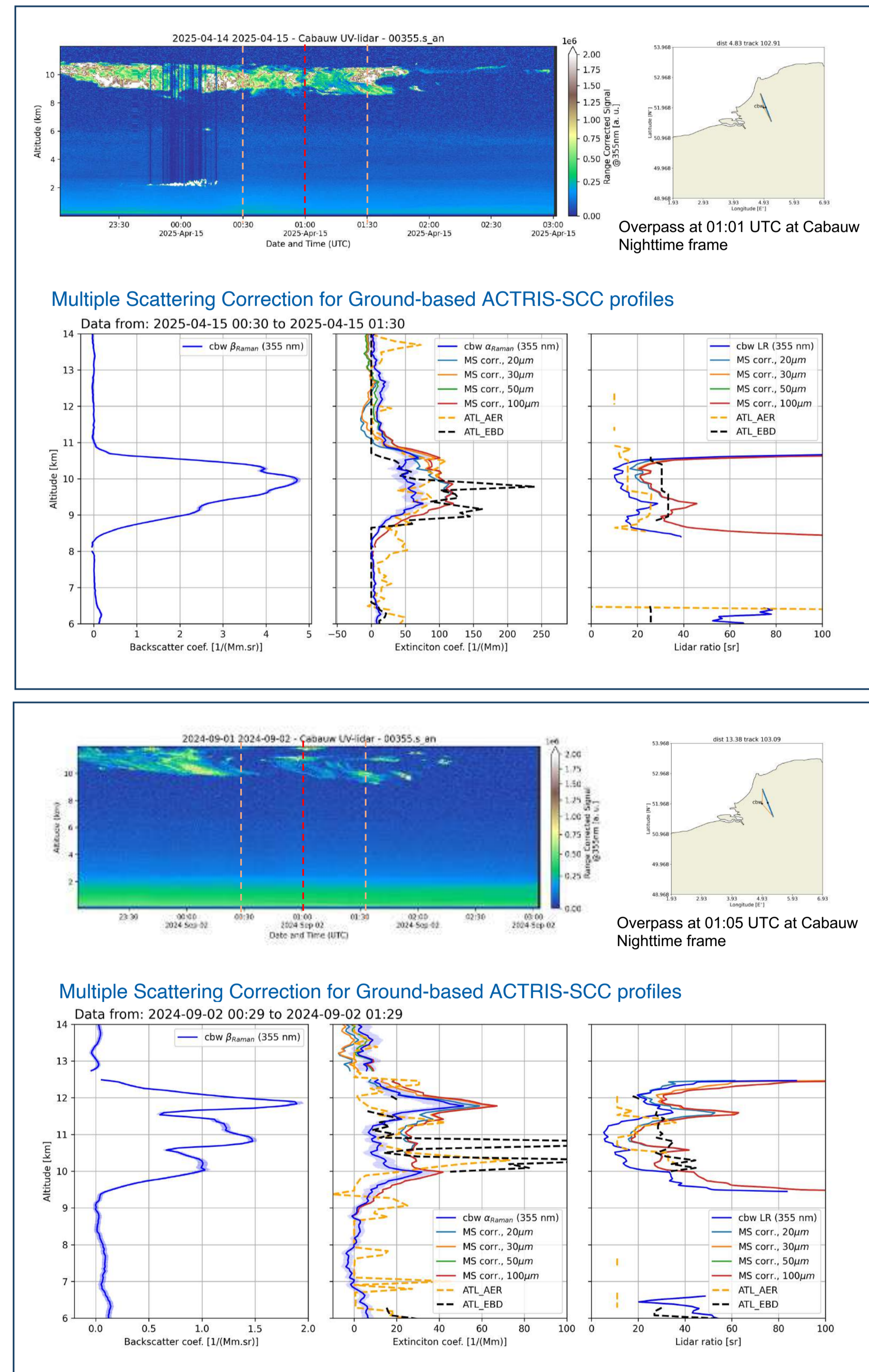
MS effects – Simulated lidar signal



Multiple scattering simulations for different ice crystal sizes (top left), laser wavelengths (top right) and receiver field-of-view (bottom left). Bottom right: RMSE from the linear fit between the molecular signal above the cloud top and the expected signal from the Rayleigh theory, for a lidar system (355nm) with laser divergence of 0.2 mrad and RFOV of 1.0 mrad. Cirrus with ext. coeff. of 0.3 km^{-1} (COD 0.6), LR of 30 sr and effective radius of 30 μm .

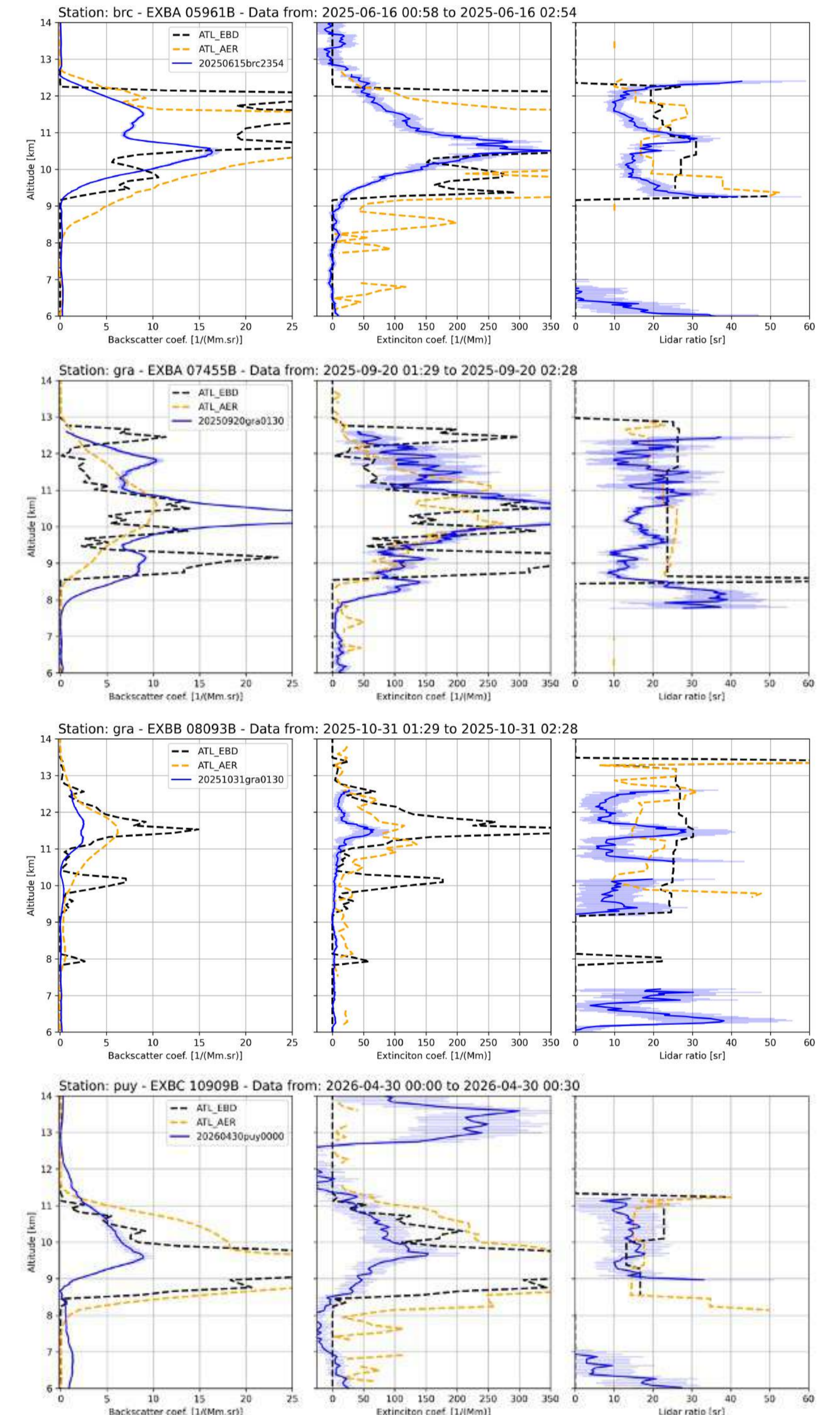
- Artificial signal in the backscatter profile, influencing the signal even above the top of the simulated cloud (15km)
- SS/MS ratio has a non-linear dependence on the distance above the cloud and thus distorting the molecular scattering expected by a purely molecular atmosphere
- A simple MS constant is not sufficient to correct the optical depth nor Lidar ratio

Cirrus Correlative Measurements at Cabauw



ACTRIS/EARLINET stations

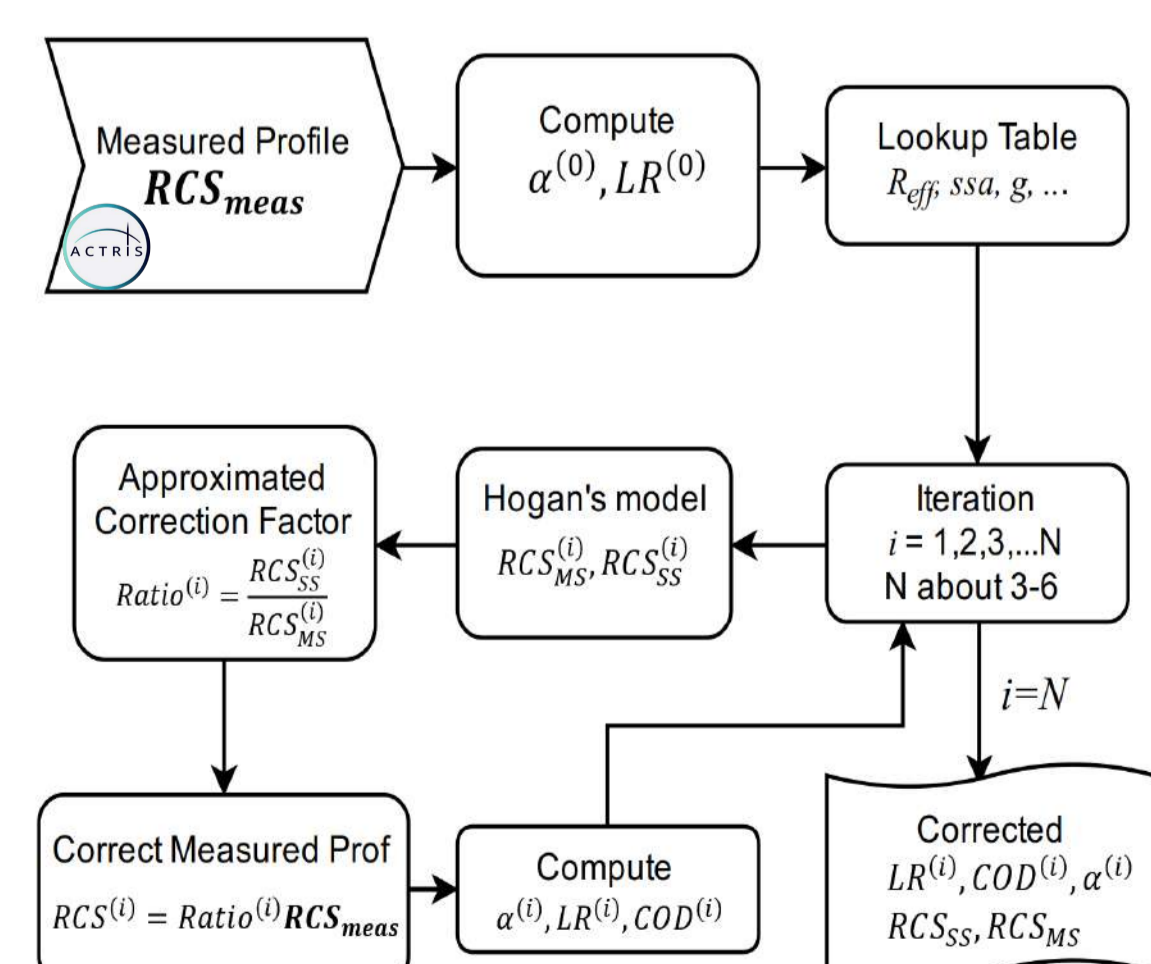
Building up statistics



- Limited overpass opportunities (~ 6 nighttime cases over Cabauw)
- Other suitable cases from ACTRIS partners will be analyzed

Correction for Multiple Scattering

- **Problem: Highly dependent on the lookup table!** The correction can be done very easily as long as accurate information of the effective radius of the ice crystals are available
- Without knowing r_{eff} , the problem becomes undetermined
- Iterative process might converge even with a wrong effective ice crystal size.



Conclusions and Outlook

Conclusions

This is ongoing work. The initial results from observations at the Cabauw site are promising. The MS modeling for the ACTRIS lidar data products shows that the prescribed a priori values for the ice particle effective radii may have an impact on the final ground-based extinction and lidar ratio retrievals, but the uncertainties are still acceptable. The number of nighttime cases for direct comparison at Cabauw is still limited, but intensive properties such as the lidar ratio can provide valuable information even for single cases. Preliminary comparisons indicate a significant difference between ATL_AER_L2A and ATL_EBD_L2A retrievals in cirrus, and some evidence that the lidar ratio from ATL_AER_L2A is underestimated. A number of correlative observations with good cases for cirrus validation was identified at other ACTRIS stations. The next step will be the application of the MS correction to these observations and build-up robust statistics for the validation.

References

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