Innovation in Atmospheric Measurement Techniques Workshop

DUAL FIELD-OF-VIEW DEPOLARIZATION METHOD USING THE POLLY^{XT} RAMAN LIDAR OF CARO LIMASSOL NATIONAL FACILITY: PARAMETERIZATION OF AEROSOL-CLOUD INTERACTIONS

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This project has received funding from the European Union's "Horizon 2020 Research and Innovation Programme" under Grant Agreement No 857510".

This project has received funding from the Government of the Republic of Cyprus through the "Directorate General for European Programmes, Coordination and and Development".

This project is co-funded by the Cyprus University of Technology

Cyprus Atmospheric Remote-Sensing Observatory (CARO) National Facility

- **Ground-based station located in Limassol**
- **Consists of an aerosol remote sensing (ARS) and a cloud remote sensing (CRS) observational platform.**
- **Offers complete insights into the atmospheric dynamics, the aerosol load in the atmosphere, as well as the dynamics of the clouds.**

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Polly^{XT} Raman Lidar

→ Multi-wavelength lidar system for detailed atmospheric profiling

→ It operates at 355, 532 and 1064 nm (day and night), capable of measuring the Raman-shifted molecular signals at 387, 407, 607 nm (only during the night)

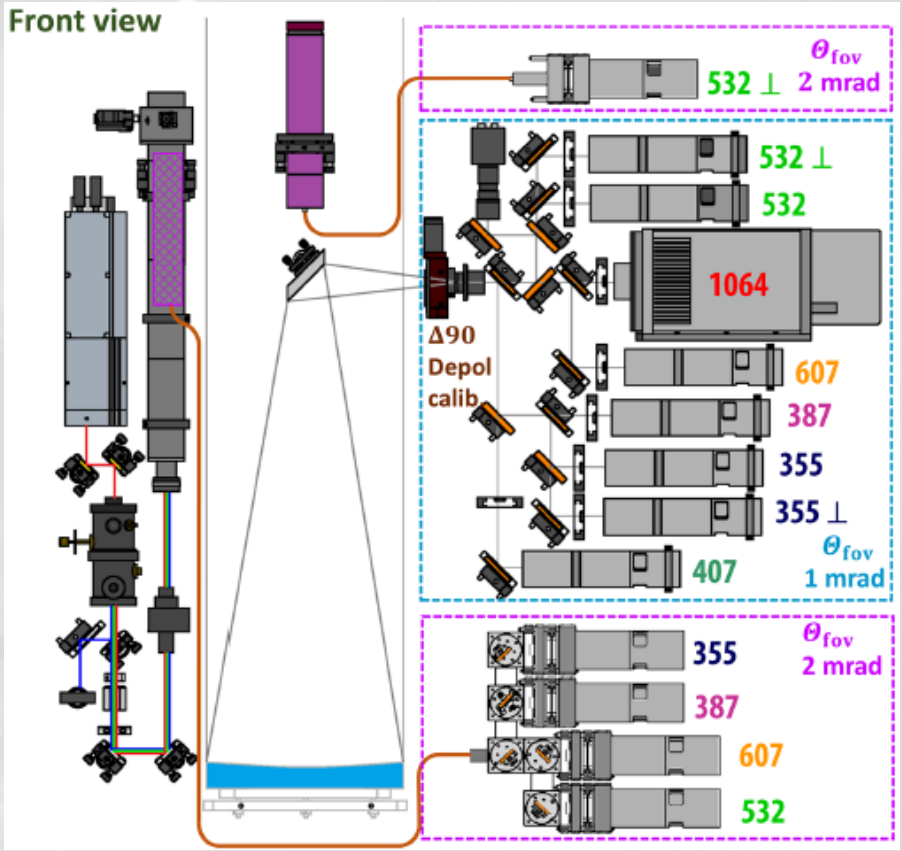
→ It can measure in two different field-of-views:

8 far-range channels (1mrad)

5 near-range channels (2mrad)

→ Derives the backscatter (β) and extinction (α) coefficients

→ Volume depolarization ratio (δ) at 355 and 532 nm



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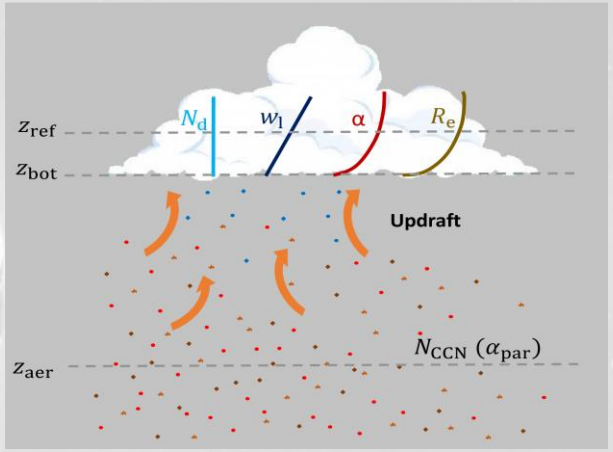
Dual-Field-of-View (DFOV) Polarization Lidar Technique

→ This method was developed by Jimenez C. et al., 2020, as a follow-up development of the DFOV Raman lidar technique (Schmidt et al., 2013).



Derives crucial information about the microphysical properties of liquid-water clouds, such as:

- Droplet number concentration (N_d)
- Effective radius of the droplets (R_e)
- Liquid Water Content (w_l)
- Cloud extinction coefficient (α)

→ Along with the synergistic use of a Doppler Lidar and by applying the POLIPHON method *(Mamouri and Ansmann, 2014, 2016)*, "detailed studies of the impact of aerosol particles on the microphysical properties of droplets in the cloud base region of liquid water cloud layers have become possible".

Therefore, this method can significantly contribute to Aerosol-Cloud Interaction (ACI) studies that, according to the latest IPCC report, still remain one of the most uncertain radiative forcing parameters.

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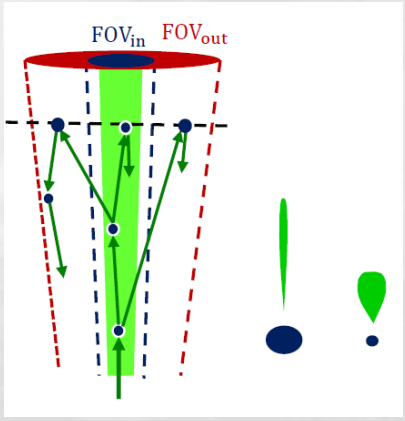

When the lidar beam enters the cloud, it enters a region where multiple scatterings occur due to the presence of droplets

The light is backscattered from greater angles

The plane of the electric field changes

The polarization of the received light is different!!

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Dual-Field-of-View (DFOV) Polarization Lidar Technique

→ By using the second telescope with the wider Field-of-View we are able to detect and record these multiple scatterings.

→ Use of 532 nm (total and cross) channels of both FOVs to determine the depolarization that each one records.

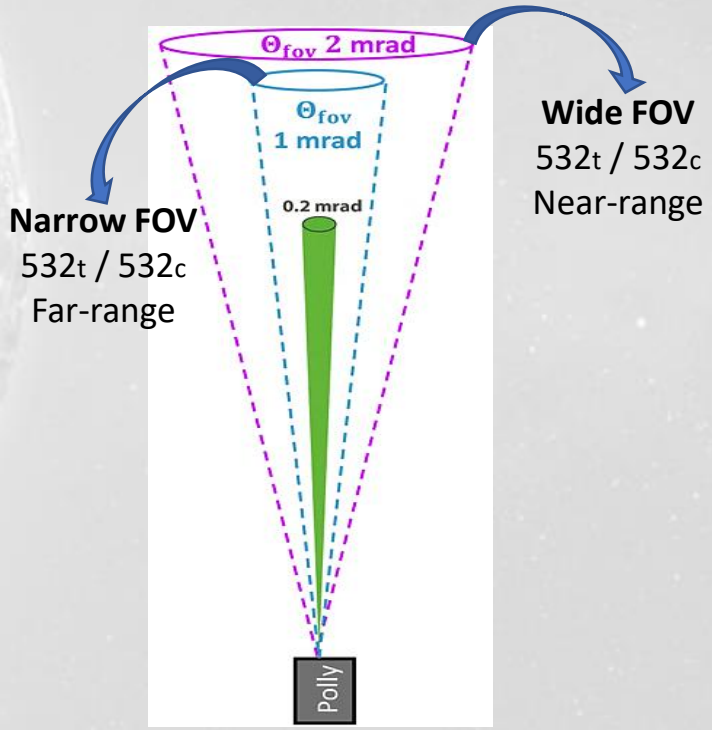
$$\overline{\delta}_{rat} = \frac{\delta_{in}}{\delta_{out}}$$

$$R_e(z_{ref}) = R_0 + R_1 \times \overline{\delta}_{rat} + R_2 \times \overline{\delta}_{rat}^2 + R_3 \times \overline{\delta}_{rat}^3$$

$$\alpha(z_{ref}) = \alpha_0(R_e, z_{bot}) + \alpha_1(R_e, z_{bot}) \times \overline{\delta}_{in} + \alpha_2(R_e, z_{bot}) \times \overline{\delta}_{in}^2$$

$$w_l(z_{ref}) = \frac{2}{3}\rho_w \alpha R_e$$

$$N_d(z_{ref}) = \frac{1}{2\pi k}\alpha R_e^{-2}$$



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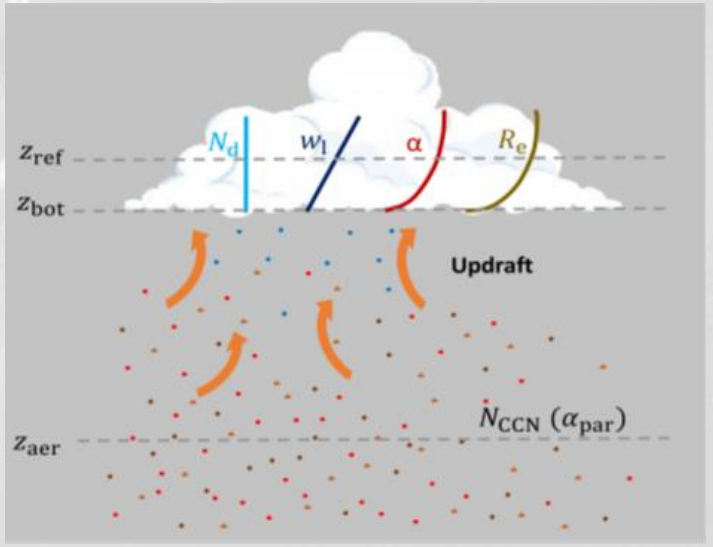

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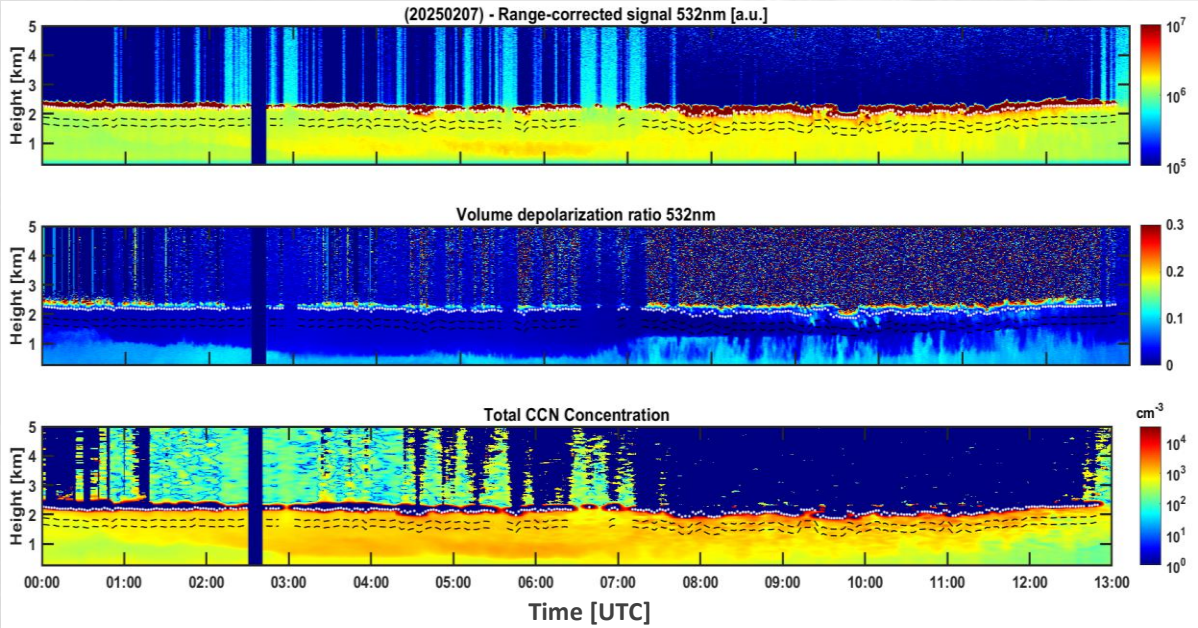
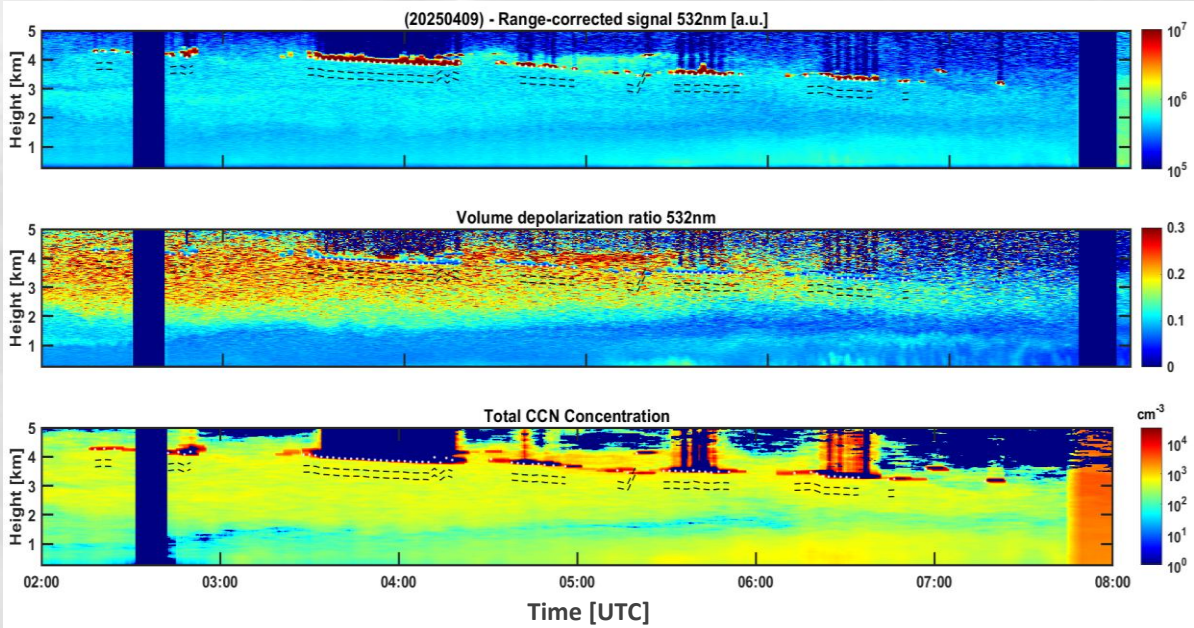
Cyprus Cases

07 Feb. 2025 – mostly marine particles & local pollution



09 Apr. 2025 – Presence of Saharan Dust



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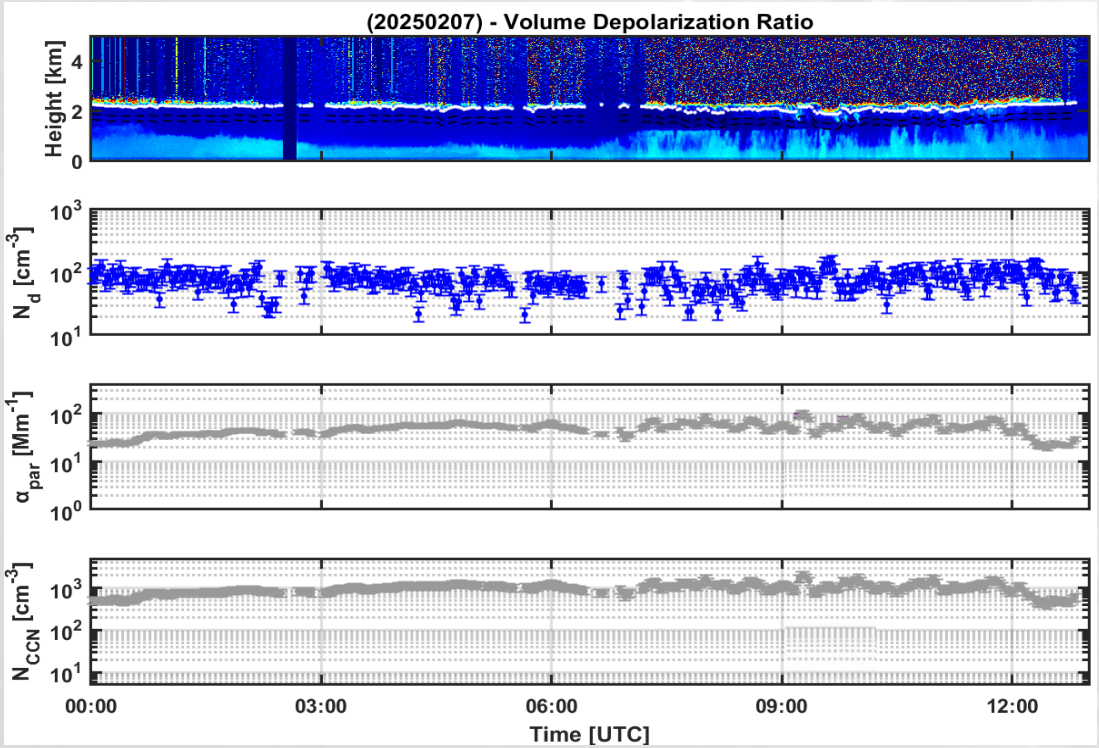

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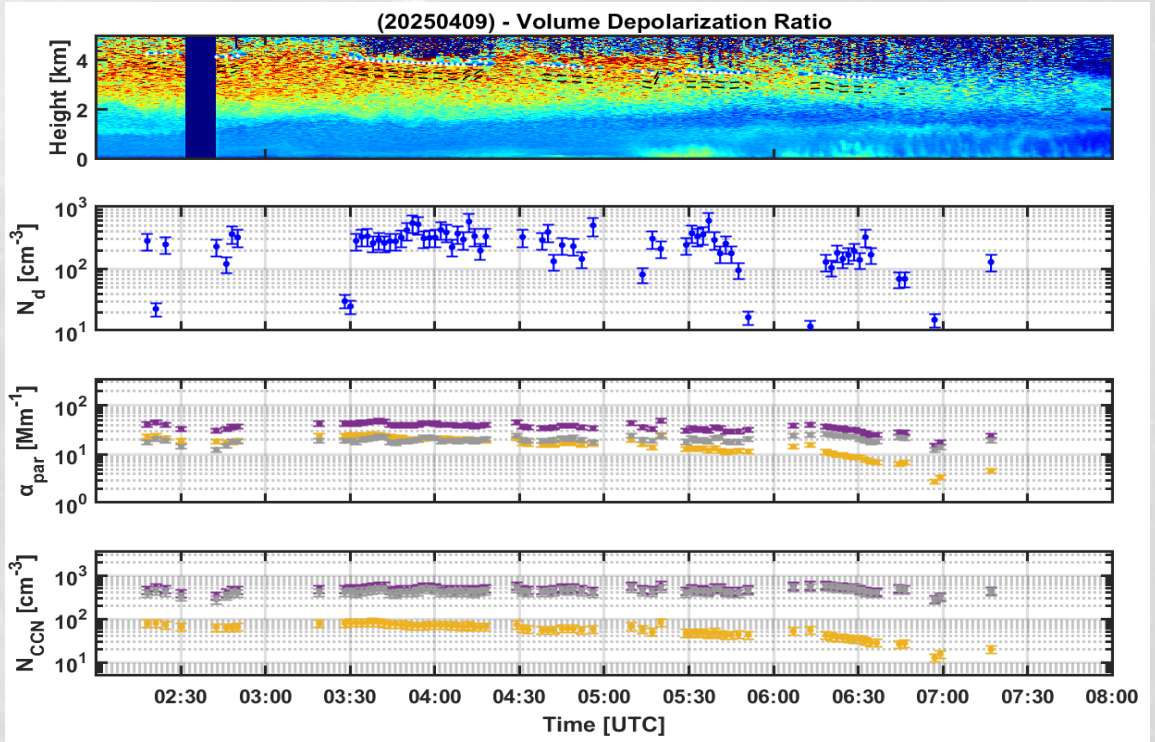

Non-dust Dust Total

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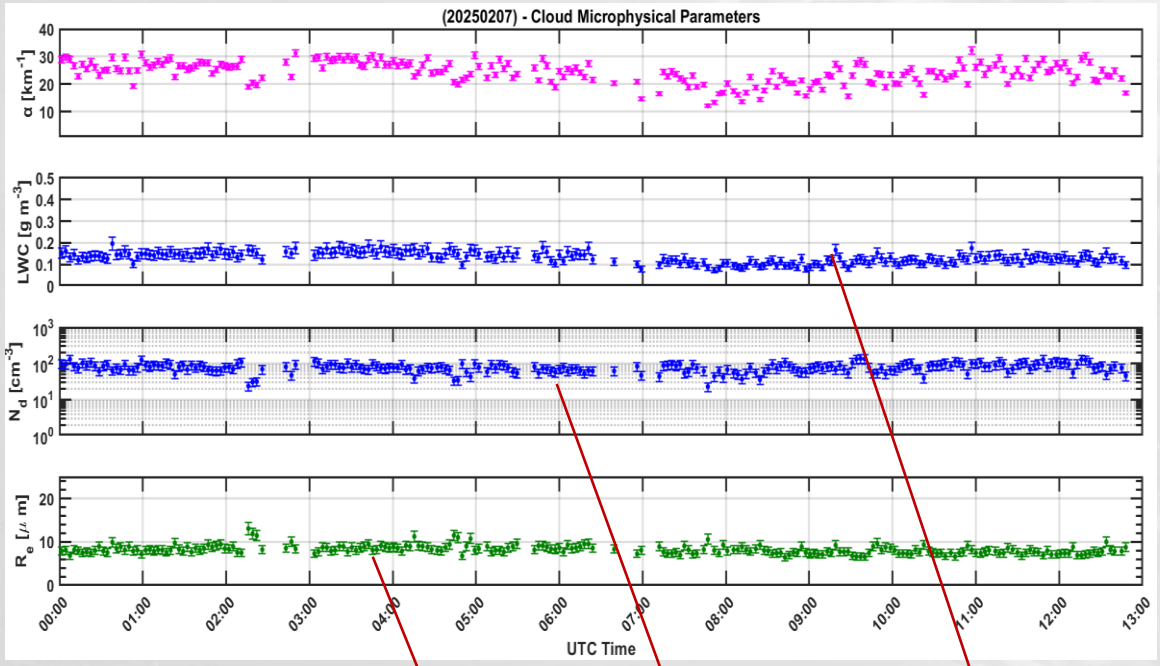

~ 10 µm

< 100 cm^{-3}

0.1-0.2 g/m^3

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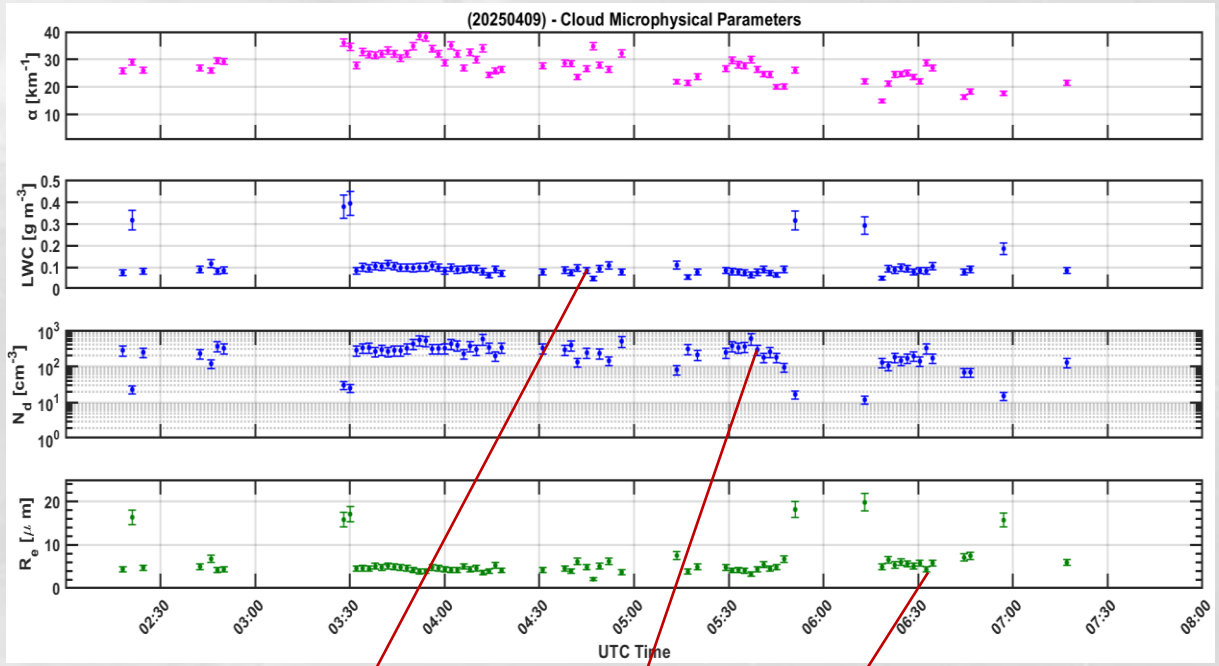

~ 0.1 g/m^3

> 100 cm^{-3}

~ 5 µm

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Conclusions

→ The DFOV Depolarization approach gives crucial and in-detail information of the aerosol-cloud interactions, just by using lidar products

→ Marine particles are found to be better CCN instead of dust (few cases of liquid-water clouds in dust - dust acts better as INP)

→ In general, smaller droplets were found in dust cases, as well as higher droplet number concentration (N_d)

→ As a next step, the information of the vertical wind needs to be implemented in order to examine how wind updrafts or downdrafts affect cloud formation processes.

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Thank you

Any questions?

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Funded by the European Union

This project has received funding from the European Union's Horizon Europe Framework Programme under the grant agreement No 101160258. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union.

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