

Introduction

The Eastern Mediterranean, particularly Cyprus, is influenced by the transport of air masses from the Sahara Desert and the Arabian Peninsula. Many studies have shown that some optical and microphysical characteristics of these two aerosol types differ.

The main objective of the present study is to investigate the optical and the microphysical characteristics of desert dust from both regions with the synergy of Polarization Polly^{XT} Raman Lidar and the Cimel sun/sky photometer.

The analysis is performed utilizing the Generalized Retrieval of Atmosphere and Surface Properties (GRASP) algorithm. GRASP is a highly flexible inversion algorithm applicable in a variety of domains, including observations from both active and passive remote sensing methods. The algorithm is based on the general principles of numerical inversion and atmospheric radiation modelling. Lopatin et al. (2013, 2021) first proposed the application of the GRASP algorithm, utilizing the synergy between multi-wavelength Lidar and the Aerosol Robotic Network (AERONET) sun/sky photometer observations.

Methodology & Data

Aerosol observations from the Polly^{XT} Polarization Raman Lidar and the CUT-TEPAK AERONET (Aerosol Robotic NETWORK) sun/sky photometer of the Cyprus Atmospheric Remote Sensing Observatory National facility (CARO NF) of ERATOSTHENES Centre of Excellence provide the vertical aerosol characteristics to the algorithm, while the sun photometer provides constraints on the quantity and type of aerosol. Saharan and Arabian Dust-dominated cases were analyzed with GRASP algorithm and compared with measurements from the instruments.

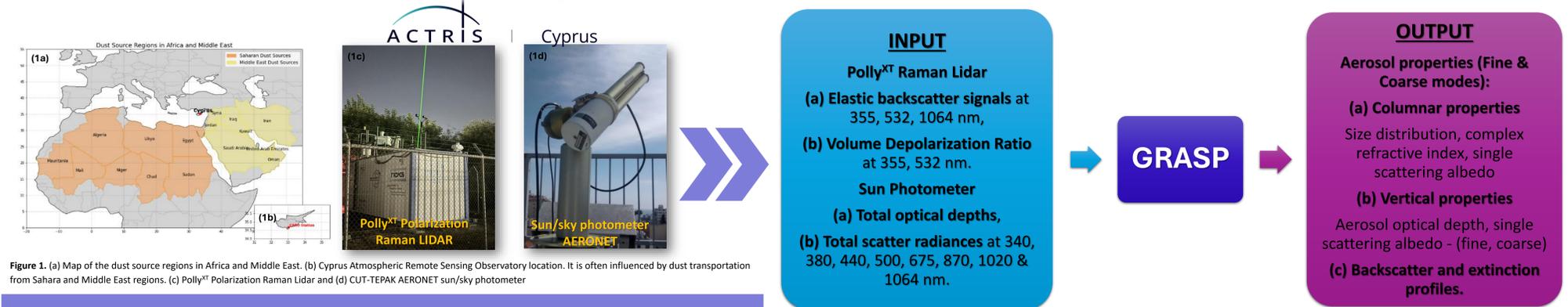
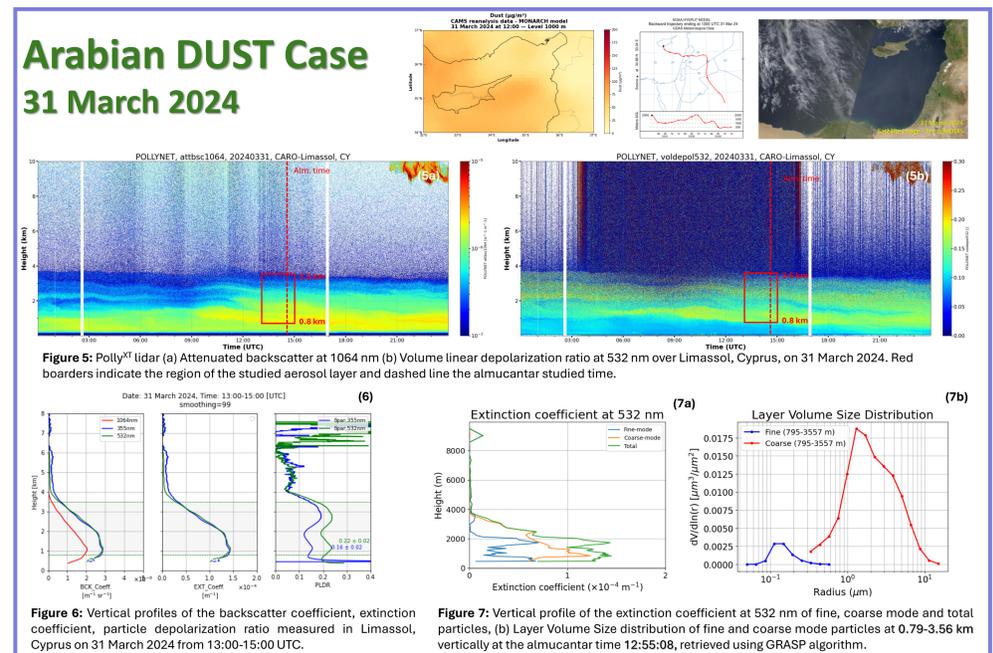
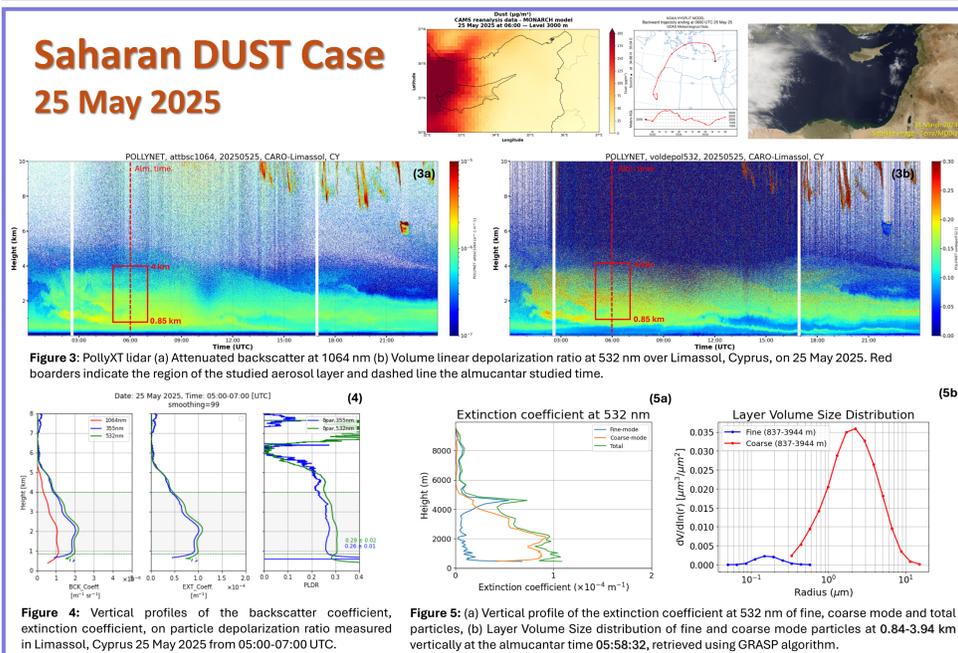


Figure 1. (a) Map of the dust source regions in Africa and Middle East. (b) Cyprus Atmospheric Remote Sensing Observatory location. It is often influenced by dust transportation from Sahara and Middle East regions. (c) Polly^{XT} Polarization Raman Lidar and (d) CUT-TEPAK AERONET sun/sky photometer

Figure 2: Input and output of the GRASP algorithm.

Results



Layer information

Case	Time (UTC)	Almucantar time	Layer height (km)	Optic info				Micro info						
				$\delta_{355 \text{ nm}}$ [%] (LIDAR)	$\delta_{532 \text{ nm}}$ [%] (LIDAR)	$S_{355 \text{ nm}}$ (sr)*	$S_{532 \text{ nm}}$ (sr)*	AOD _{532 nm} (LIDAR)	AOD _{532 nm} (GRASP)	AOD _F 532 nm (GRASP)	AOD _C 532 nm (GRASP)	SSA _F 440 nm (GRASP)	SSA _C 440 nm (GRASP)	SSA 440 nm (GRASP)
Saharan	05:00 - 07:00	05:58:32	0.85 - 4	0.26 ± 0.01	0.29 ± 0.02	50	50	0.274	0.237	0.024	0.212	0.756	0.982	0.951
Arabian	13:00 - 15:00	12:55:08	0.8 - 3.5	0.16 ± 0.02	0.22 ± 0.02	50	50	0.281	0.223	0.55	0.168	0.738	0.984	0.904

Columnar information

Case	Almucantar time	Height	Optic info				Micro info						
			AOD _{440 nm} (GRASP)	AOD _{440 nm} (AERONET)	AE _{440-870 nm} (AERONET)	$\eta_{R,440 \text{ nm}}$ (GRASP)	$\eta_{I,440 \text{ nm}}$ (GRASP)	$\eta_{R,C,440 \text{ nm}}$ (GRASP)	$\eta_{I,C,440 \text{ nm}}$ (GRASP)	Reff _F (μm) (GRASP)	Reff _C (μm) (GRASP)	SSA 440 nm (GRASP)	
Saharan	05:58:32	05:58:32	Columnar	0.362	0.368 ± 0.009	0.224 ± 0.007	1.56	0.069	1.51	0.0004	0.178	2.526	0.913
Arabian	12:55:08	12:55:08	Columnar	0.306	0.291 ± 0.005	0.376 ± 0.0114	1.53	0.069	1.47	0.0001	0.153	2.512	0.887

Conclusions

Saharan and Middle East dominated cases were analyzed, utilizing Polly^{XT} Raman Lidar, sun-photometer and GRASP algorithm retrievals.

❖ The properties of size, sphericity, absorption and quantity of the three aerosol cases in the atmospheric column and in layers are presented.

❖ Agreement GRASP algorithm parameters with AERONET

- Total SSA at 440 nm and AOD at 440 nm have Excellent agreement with AERONET measurements

❖ Additional information from GRASP algorithm

- For Saharan and Arabian dust layers SSA property showed that fine particles are strongly absorbing and coarse nearly all scattering.

- The columnar $\eta_{I,C}$ indicated non-absorbing coarse-mode particles and columnar $\eta_{I,F}$ indicated strongly absorbing fine-mode particles for both studied cases. This is consistent with the SSA for coarse particles.

- The vertical profile of extinction coefficients for the fine, coarse mode and total particles. It revealed distinct particle mode dominance by aerosol type, characterizing the studied layers as follows: Saharan Dust - Coarse mode and Arabian Dust - Coarse mode. This highlights the importance on accurate layer aerosol classification.

*δ: Particle linear depolarization ratio; S (sr): Lidar ratio; AOD: Aerosol optical depth; AE: Angstrom Exponent; η_R : Real part of the refractive index; η_I : Imaginary part of the refractive index; Reff: Effective radius; SSA: Single Scattering Albedo; F: Fine-mode aerosols; C: Coarse-mode aerosols.