

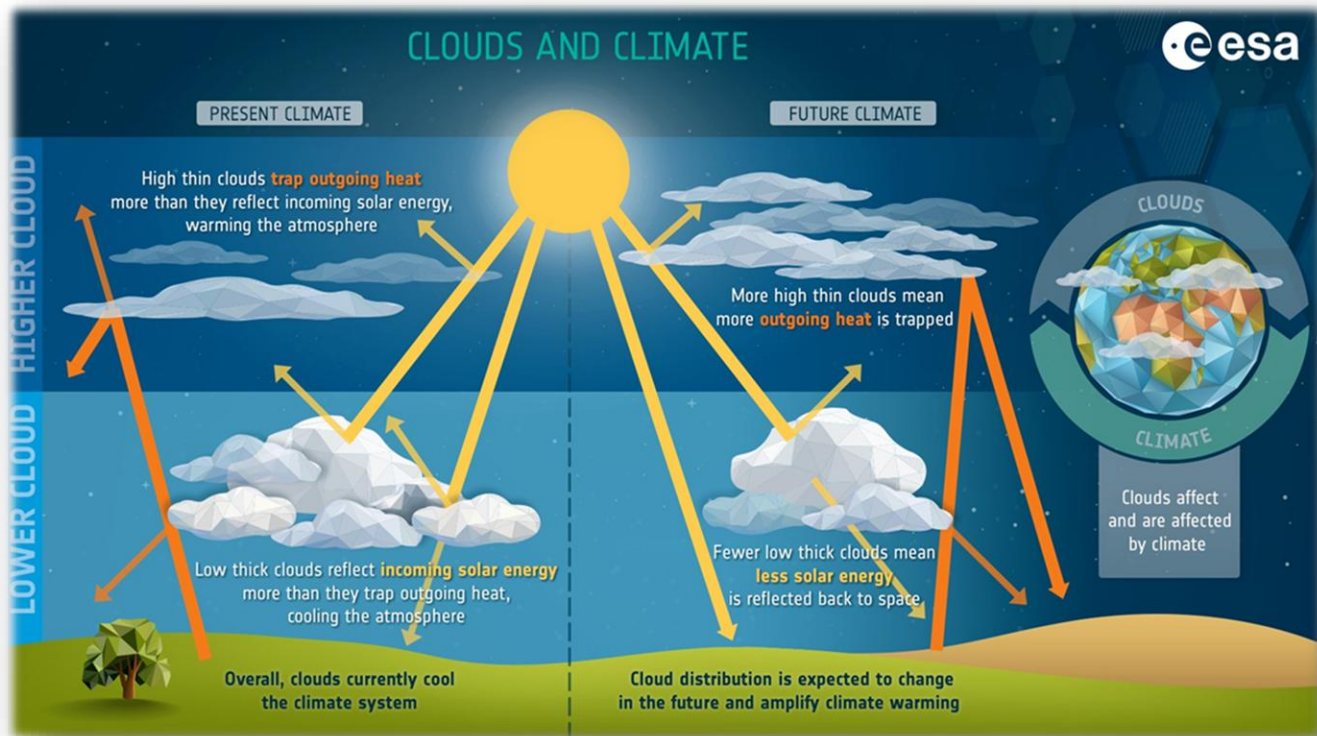


EarthCARE satellite mission Calibration and Validation activities in the Cyprus region

Maria Poutli, Rodanthi-Elisavet Mamouri, Argyro Nisantzi, Hossein Panahifar, Diofantos Hadjimitsis

Eratosthenes Centre of Excellence | Cyprus University of Technology

What is EarthCARE??



- Clouds, aerosols and radiation: key parameters for understanding the climate
- Direct & indirect impacts of aerosols in the climate
 - Absorb and scatter solar and terrestrial radiation
 - Interaction with clouds

Major challenge: to incorporate clouds, aerosols, and precipitation into climate change prediction models

EarthCARE: The joint European Space Agency (ESA)–Japan Aerospace Exploration Agency (JAXA) Earth Clouds, Aerosol and Radiation Explorer (EarthCARE) satellite mission

Provide crucial data to illustrate the complex interactions between clouds, aerosols and radiation within Earth's atmosphere

EarthCARE mission

Mission: the Earth Cloud Aerosol and Radiation Explorer (EarthCARE) satellite mission has been designed to assess how *clouds*, *aerosols* and *radiation* are represented in *weather and climate models* and to improve our understanding of their role in the climate system.

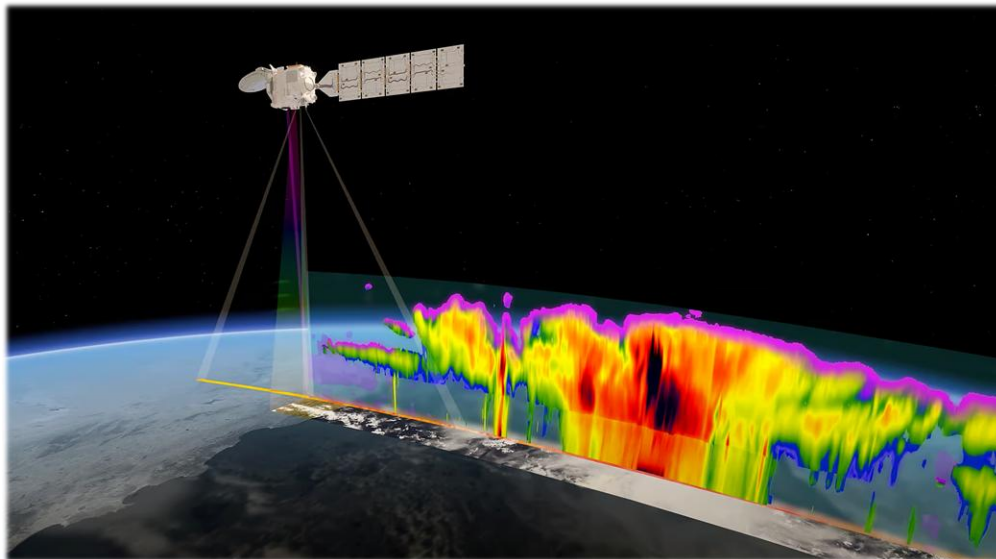
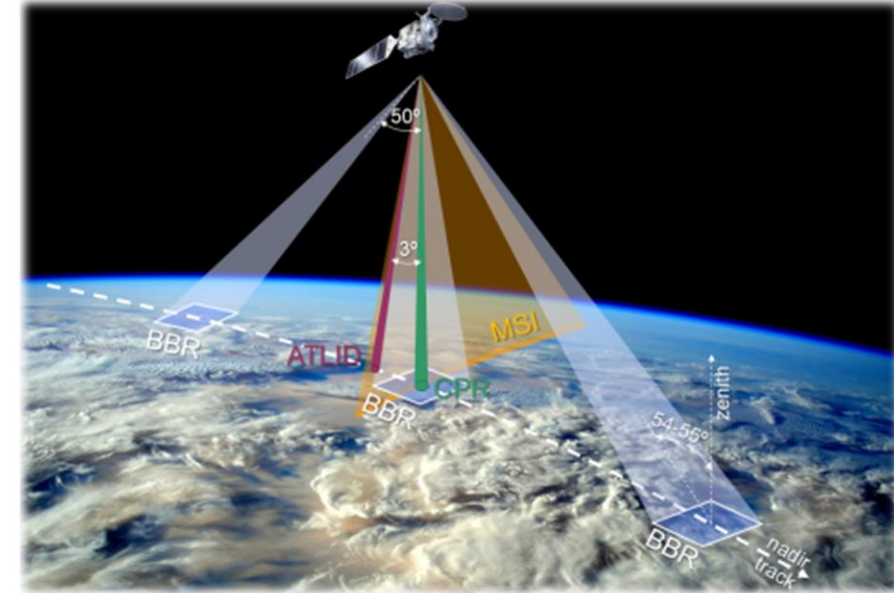
The launch

Date: 28 May 2024

Site: Vandenberg, California, US

Orbit: Sun-synchronous

Revisit time: 25 days



EarthCARE Instruments

- Atmospheric Lidar (**ATLID**)
→ vertical profiles of aerosols and thin clouds
- Broad-Band Radiometer (**BBR**)
→ measurements of top-of-the-atmosphere radiances and fluxes
- Cloud Profiling Radar (**CPR**)
→ vertical profiles measurements of clouds and observes vertical velocities of cloud particles through Doppler measurements
- Multi-Spectral Imager (**MSI**)
→ across-track information on clouds and aerosols

Calibration/Validation activities

Various calibration/validation (cal/val) activities take place for the EarthCARE mission to be successfully operated

➤ Validation

- Ensures EarthCARE data and products are accurate and meaningful
- Assesses uncertainties due to sensitivity or resolution

➤ Calibration

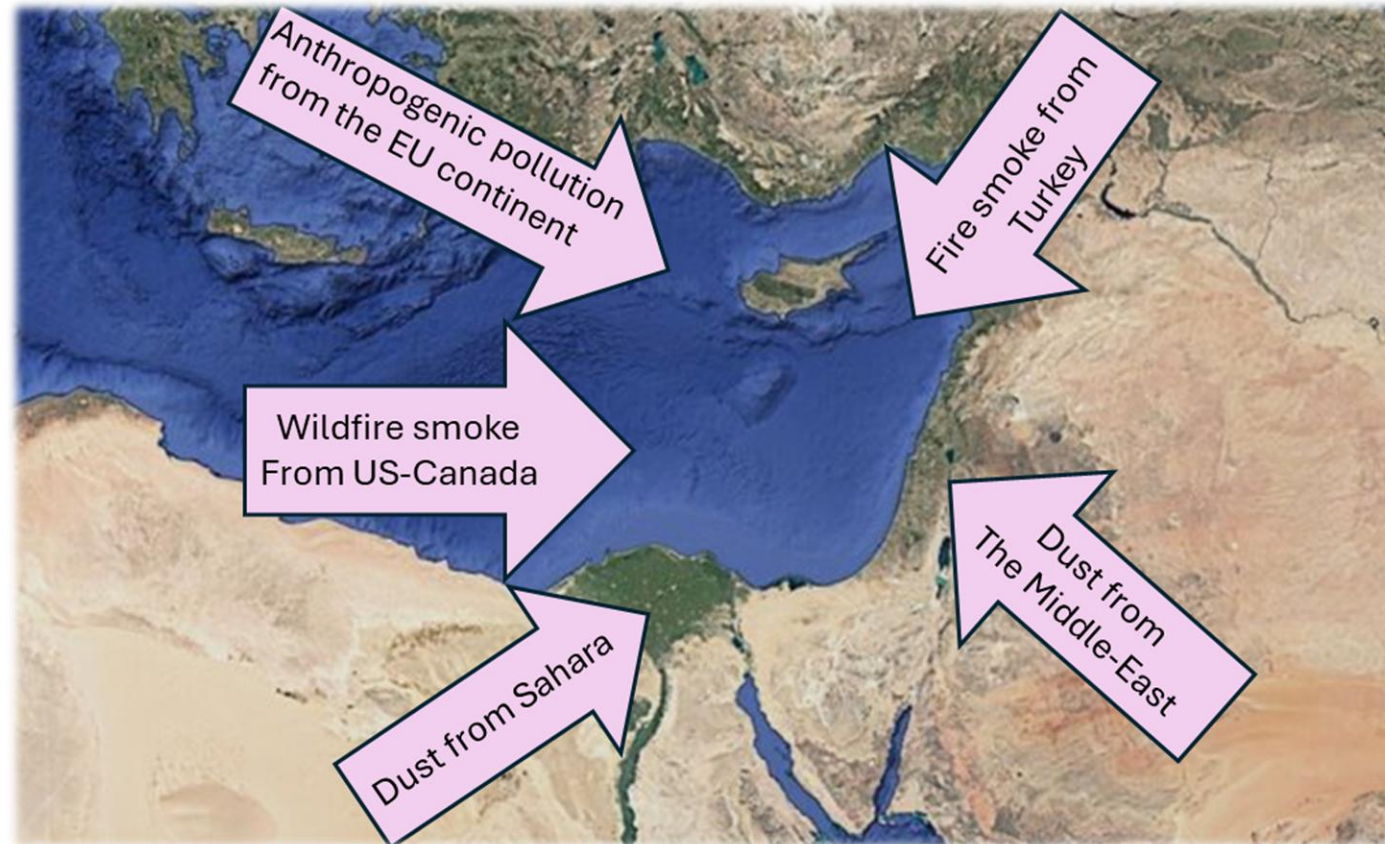
- Verifies that EarthCARE instruments perform well
- Ensures measurements align with established baselines

• Many scientific communities are involved worldwide

• **Cyprus:** key area for the cal/val activities because of its unique geographical position

→ participation the **CORAL project**

(Cyprus Observations for EarthCARE vALidation)



CARO station

ERATOSTHENES - Cyprus Atmospheric Remote Sensing Observatory (CARO)

Limassol, Cyprus (34.7°N, 33°E)

- less than 2 km from the coastline; conditions representative of typical Mediterranean and Middle East region

ACTRIS AEROSOL REMOTE SENSING OBSERVATIONAL PLATFORM

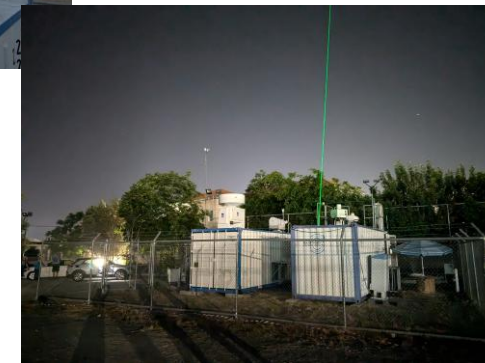
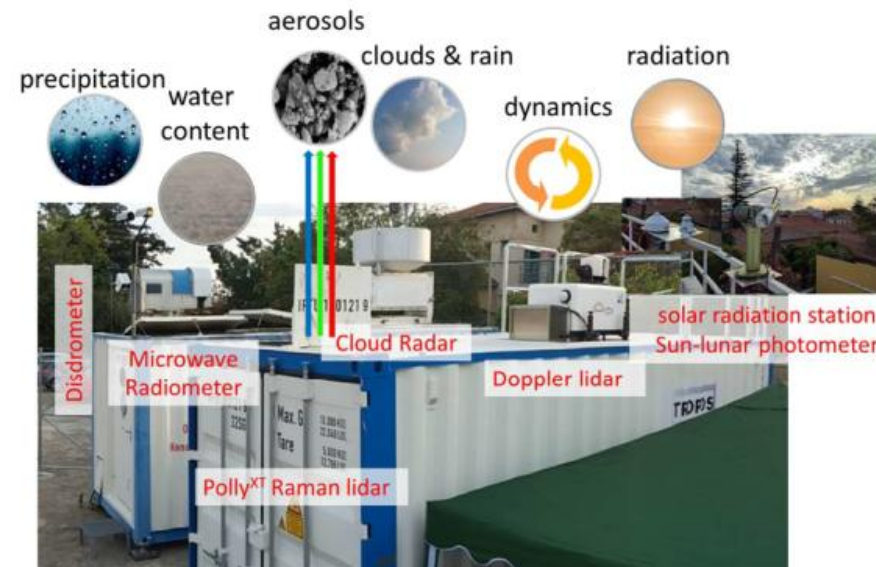
- AERONET Sunphotometer
- PollyXT
- Wind Doppler lidar (Streamline-XR)

ACTRIS CLOUD REMOTE SENSING OBSERVATIONAL PLATFORM

- microwave radiometer
- ceilometer
- optical precipitation disdrometer
- 35 GHz MiRA cloud radar

SOLAR STATION

- Sky Camera
- Brewer
- Pyranometer



CORAL project

→ **CORAL** focuses on an overall approach for the EC observations standardized Aerosol Remote Sensing (ARS), Cloud Remote Sensing (CRS) and solar radiation observations in Cyprus

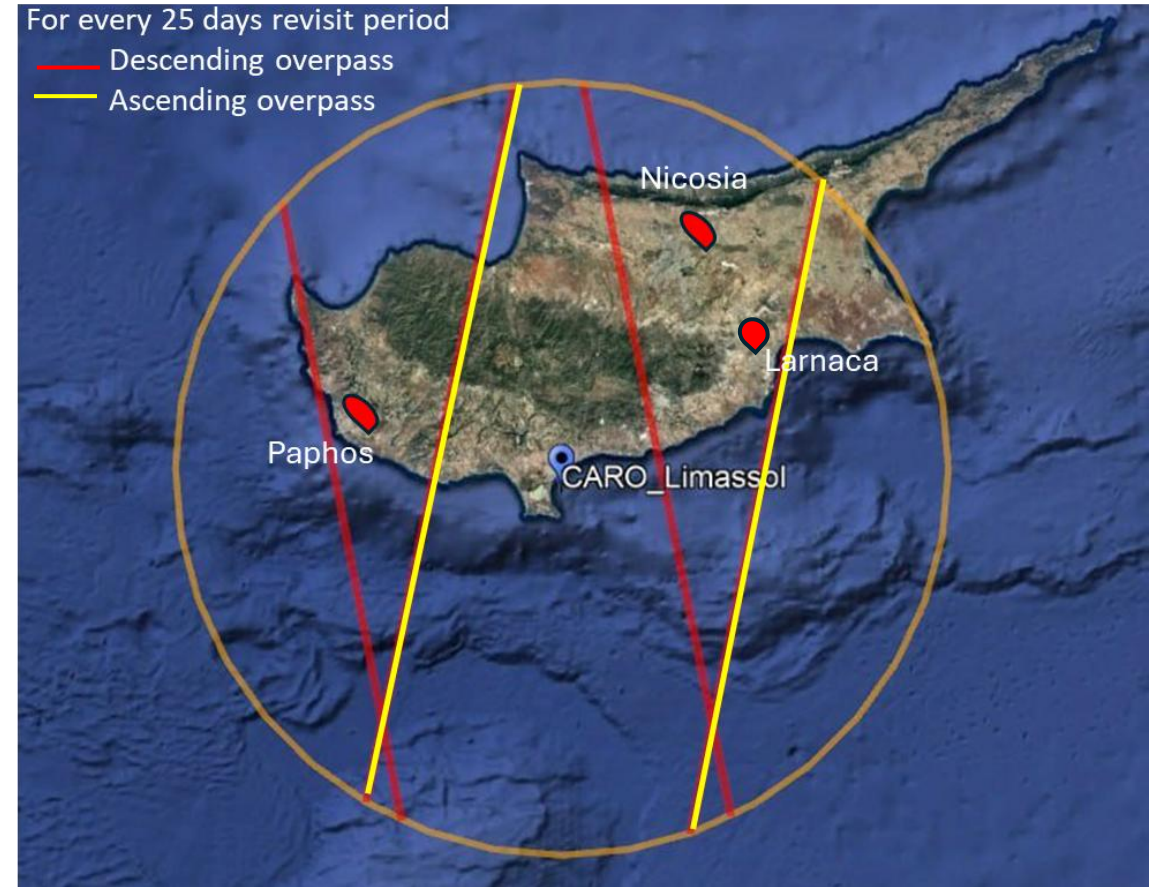
→ 4 stations taking part:

- Limassol (ARS-CRS-Solar)
- Nicosia (ARS)
- Agia Marina (Solar)
- Orounda (UAV)

Coordination: Cyprus Atmospheric Remote Sensing Observatory (CARO) of ERATOSTHENES CoE

→ **CARO station participation** with the operating **PollyXT 24/7 LIDAR**, **MIRA35 cloud radar** providing real time aerosol profiles, and **solar radiation instruments**

→ In this study we focus on the measurements of the lidar instrument



Overpasses

Total overpasses (since August 2024): **44**

Night-time (ASC): **21**

Day-time (DESC): **23**

PollyXT operation: **30**

Cloud radar operation: **25**

Ceilometer operation: **44**



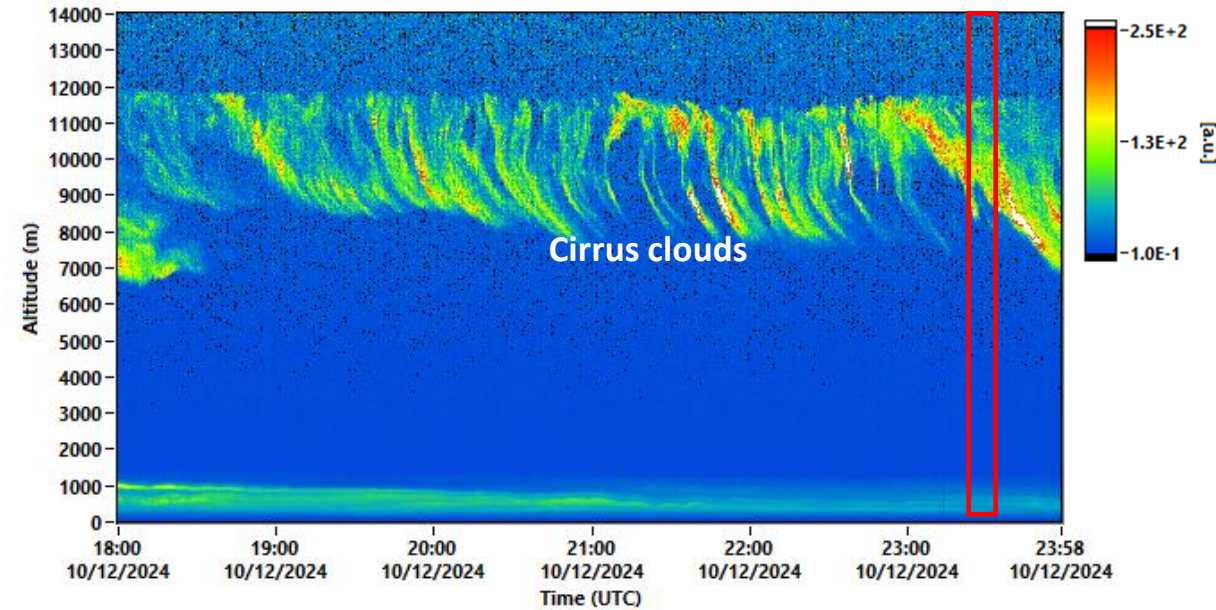
Cirrus Cloud Case

10.12.2024

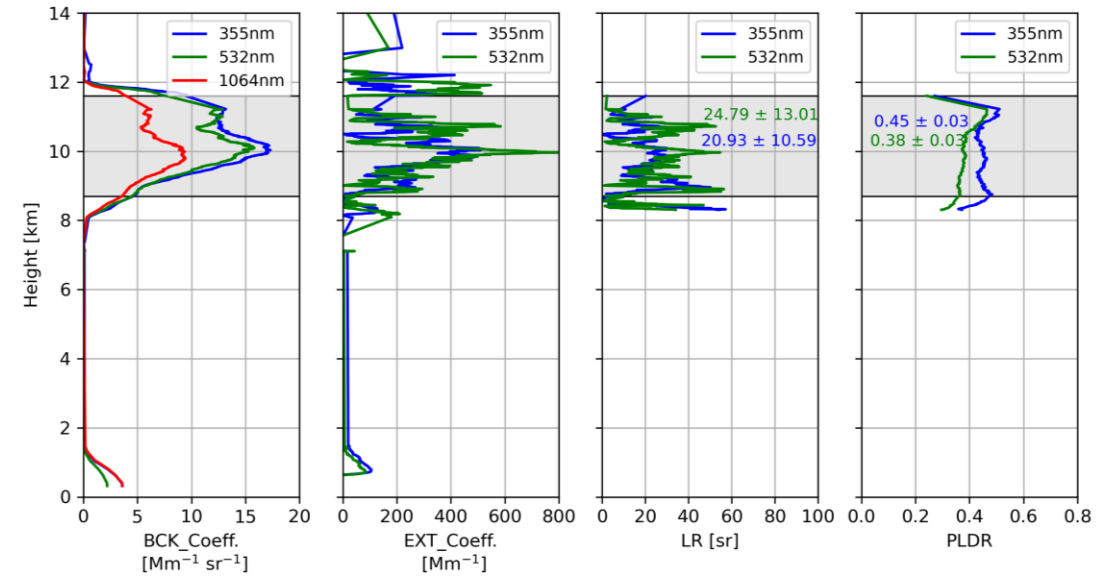
Cirrus case: 10.12.2024

Cirrus layer: ~ 8.2 - 12.0 km

Attenuated backscatter coefficient, 1064 nm



Date: 2024_12_10, Hour: 2325_2335



Optical properties	Symbol	Units	
Backscatter coefficient	β_{aer}	Mm^{-1}	Relevant to particles' load
Extinction coefficient	α_{aer}	$Mm^{-1} sr^{-1}$	Relevant to particles' load
Lidar ratio	S_{aer}	sr	Source/type of the particles
Particle depolarization ratio	δ_{par}	Dimensioless quantity	Shape of the particles

Mean Values	532 nm	355 nm
Lidar ratio (sr)	24.79 ± 13.01	20.93 ± 10.59
Part. depol. ratio	0.38 ± 0.03	0.45 ± 0.03



Typical values of cirrus cloud

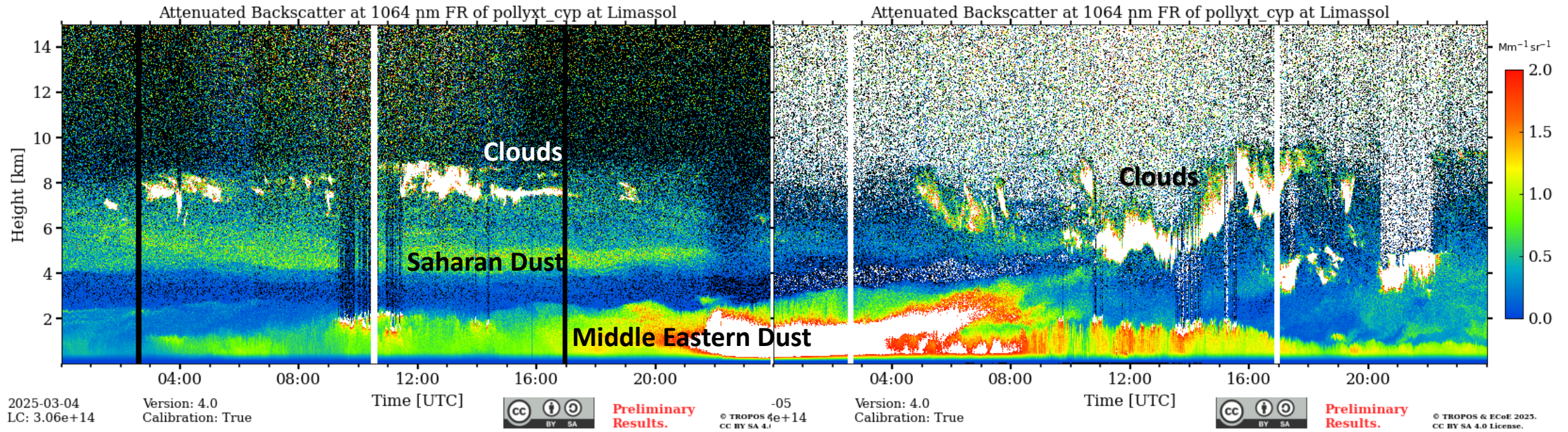
R. E. Mamouri et. al., 2023; K. A. Voudouri et. al., 2020; E. Giannakaki et. al., 2007;



Dust Case

04.03.2025

Dust case: 04.03.2025

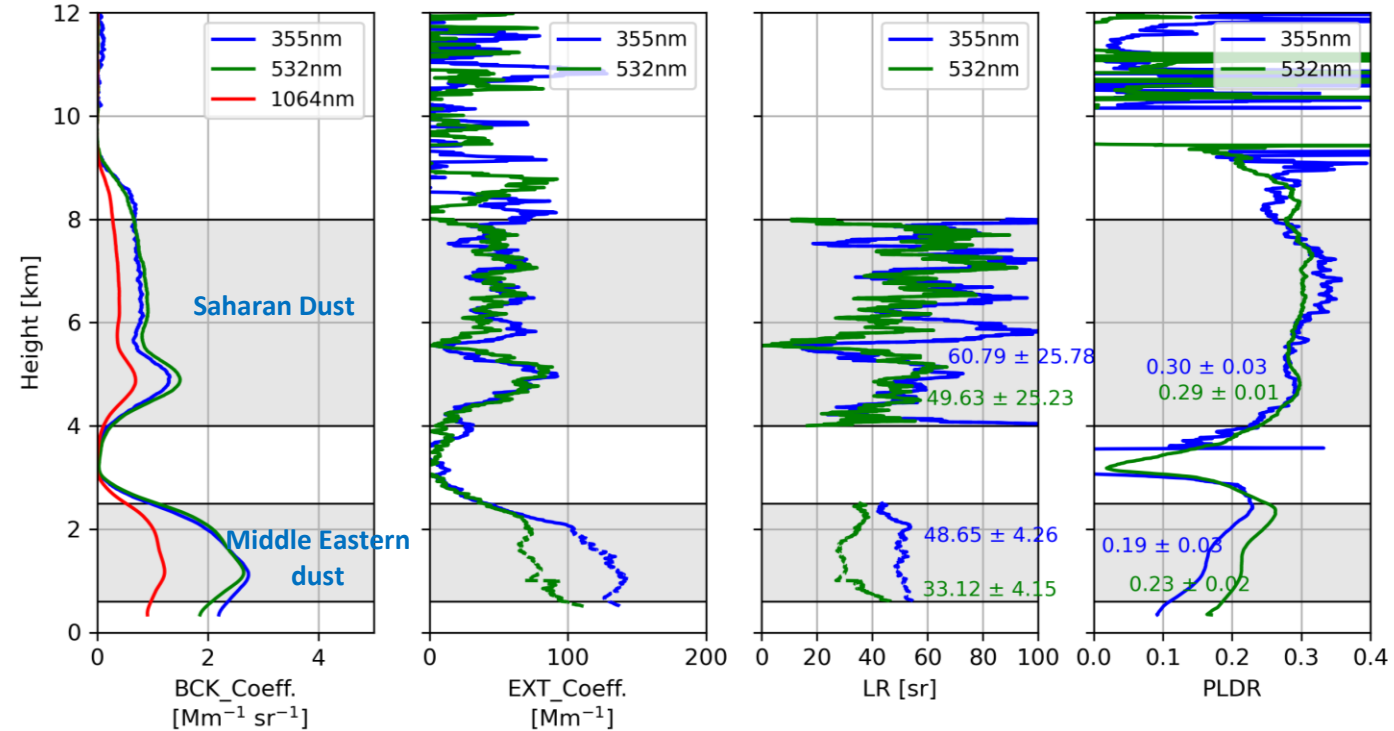
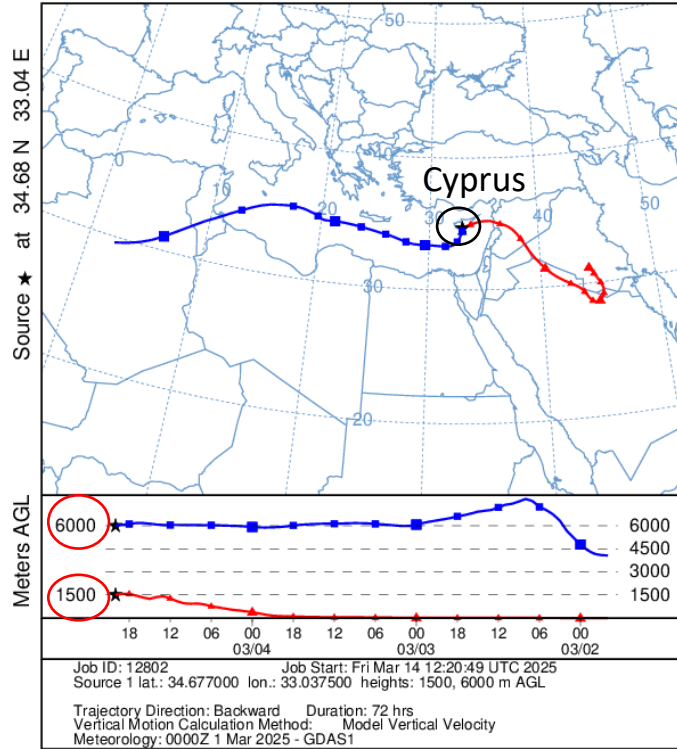


Dust case: 04.03.2025

Dust layers: ~0.6 – 2.5 km + 4.0 – 8.0 km

Date: 2025_03_04, Hour: 1930_2059

NOAA HYSPLIT MODEL
Backward trajectories ending at 2000 UTC 04 Mar 25
GDAS Meteorological Data



Mean Values	532 nm		355 nm	
	<i>Middle Eastern Dust</i>	<i>Saharan Dust</i>	<i>Middle Eastern Dust</i>	<i>Saharan Dust</i>
Lidar ratio (sr)	33.12 ± 4.15	49.63 ± 25.23	48.65 ± 4.26	60.79 ± 25.78
Part. depol. ratio	0.23 ± 0.02	0.29 ± 0.01	0.19 ± 0.03	0.30 ± 0.03

Typical values of Saharan and Middle Eastern dust

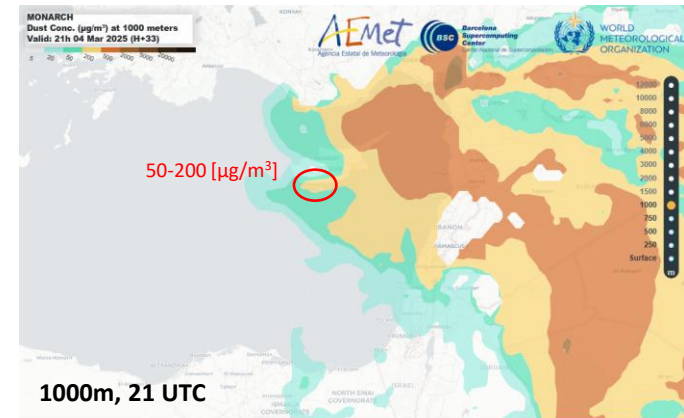
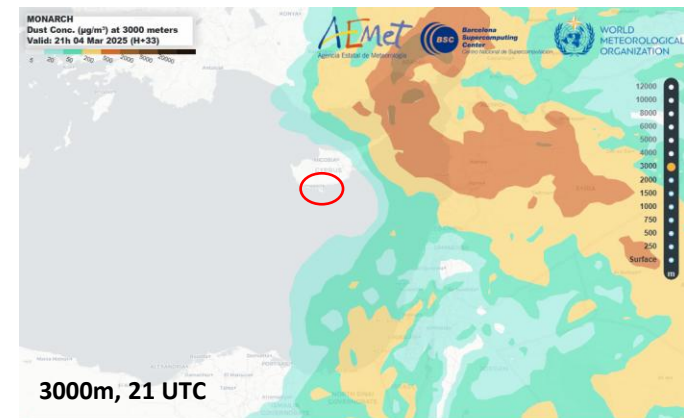
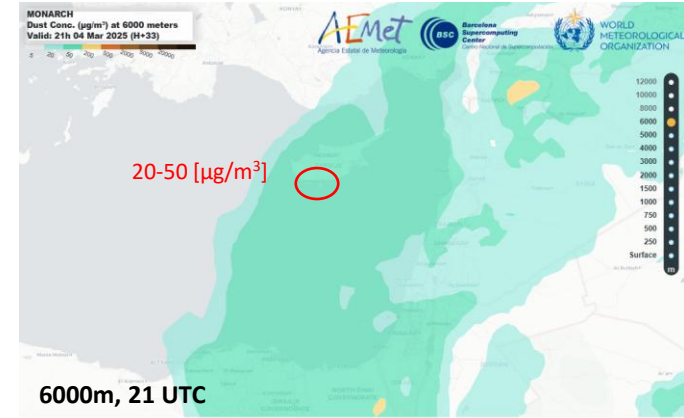
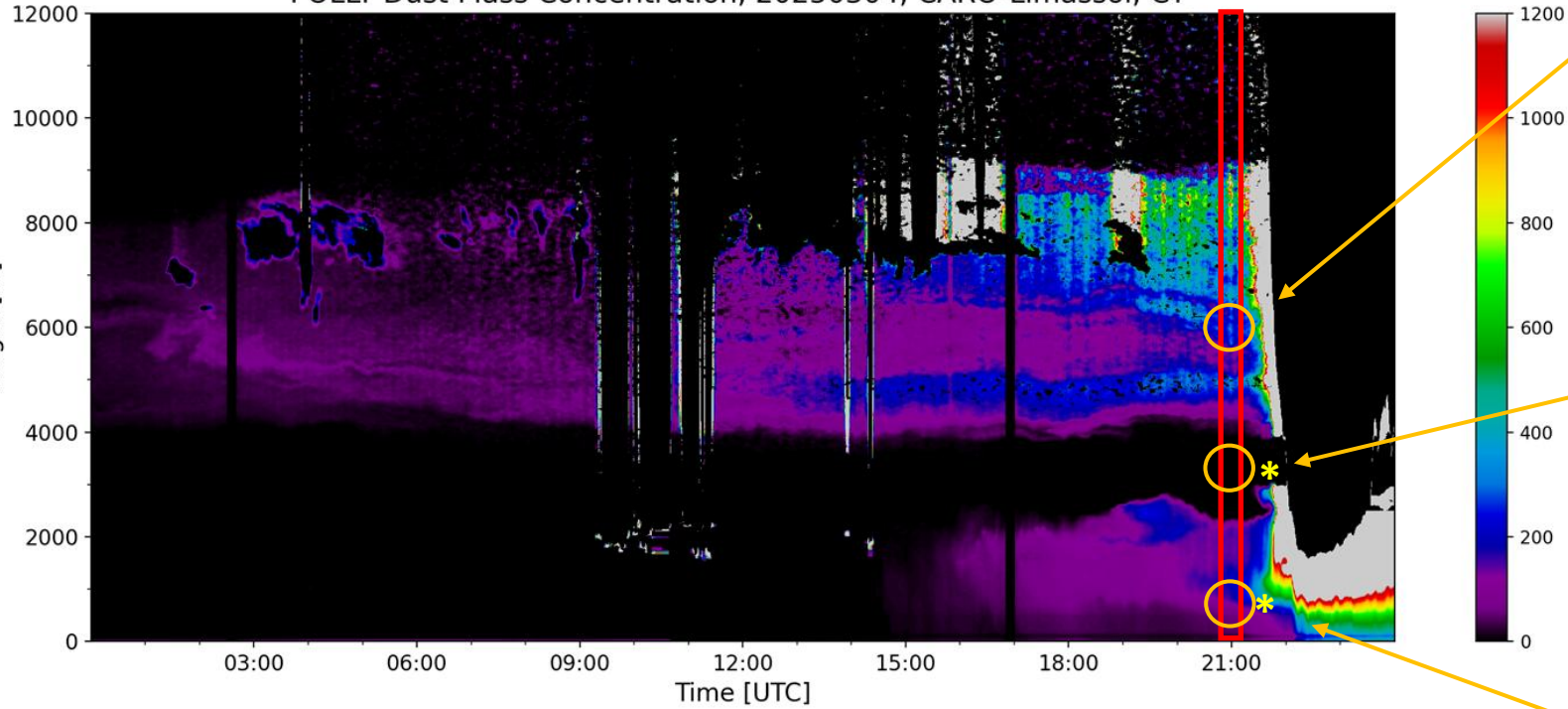


A. A. Floutsi et. al., 2023; A. Nisantzi et. al., 2015

POLIPHON METHOD → Dust Mass Concentration

polarization-lidar photometer networking → dust + non-dust particles

POLLY Dust Mass Concentration, 20250304, CARO-Limassol, CY



Conclusions

- The EarthCARE mission is led by ESA in collaboration with JAXA to collect essential data on clouds, aerosols, and radiation, and to enhance our understanding of their impact on climate.
- The calibration/validation activities are essential for assessing the products provided by the satellite.
- Cyprus is a key area involved in cal/val activities due to the unique aerosol structures observed.
- Several important cases were observed that are crucial for validating the EarthCARE satellite data (cirrus case, intense dust case).
- The role of ground-based measurements is vital for assessing satellite data and for the operation of models.



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Thank you!!!

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