



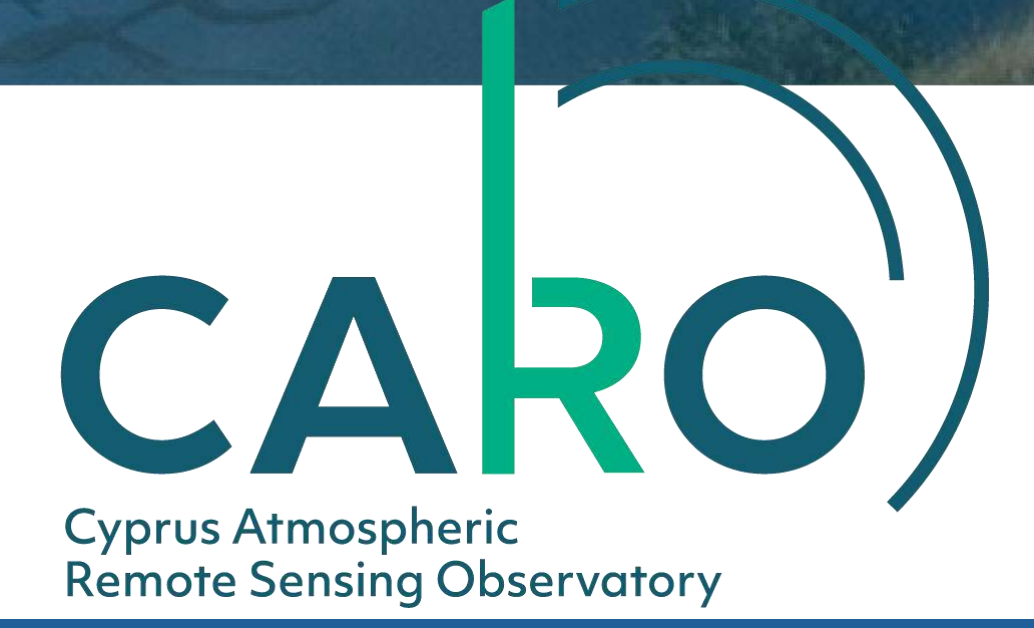
Assessing MONARCH Mineral Dust Forecasts over Cyprus with EarthCARE Aerosol Products and CARO NF



EUROPEAN SPACE AGENCY



Konstantinos Chrysostomou^{1,2}, George Kotsias¹, Emanuele Emili³, Tito Santiago Vintimilla Cruz³, Maria Poutli^{1,2}, and Rodanthi-Elisavet Mamouri^{1,2}
 1 ERATOSTHENES Centre of Excellence, Limassol, Cyprus | 2 Cyprus University of Technology, Faculty of Engineering and Technology, Limassol, Cyprus | 3 Barcelona Supercomputing Center, Barcelona, Spain
 Email of corresponding author: konstantinos.chrysostomou@eratosthenes.org.cy



Introduction

MONARCH Dust Model



- The Multiscale Online Nonhydrostatic Atmosphere Chemistry (MONARCH) model is a chemical weather prediction system.
- It focuses on mineral dust and other aerosols, atmospheric chemistry, emissions and data assimilation.
- The model's atmospheric dynamics rely on the meteorological Nonhydrostatic Multiscale Model on the B-grid (NMMB) → accurate simulation of atmospheric motions.

MONARCH simulates the complete dust life cycle: emissions (uplift by surface winds and turbulence), transport (advection, diffusion, and convective mixing), and removal via dry deposition, gravitational settling, and wet scavenging.

Forecast Products: Dust Optical Depth (DOD), Dust Concentration, Dust Extinction Coefficient, Dust Load, Wet & Dry Deposition

Time resolution: 3 hours
 Spatial resolution: $0.1^\circ \times 0.1^\circ$
 Vertical resolution: 13 discrete altitude levels (Spanning from 250 until 12000 m)

Scan to check the products & forecasts!



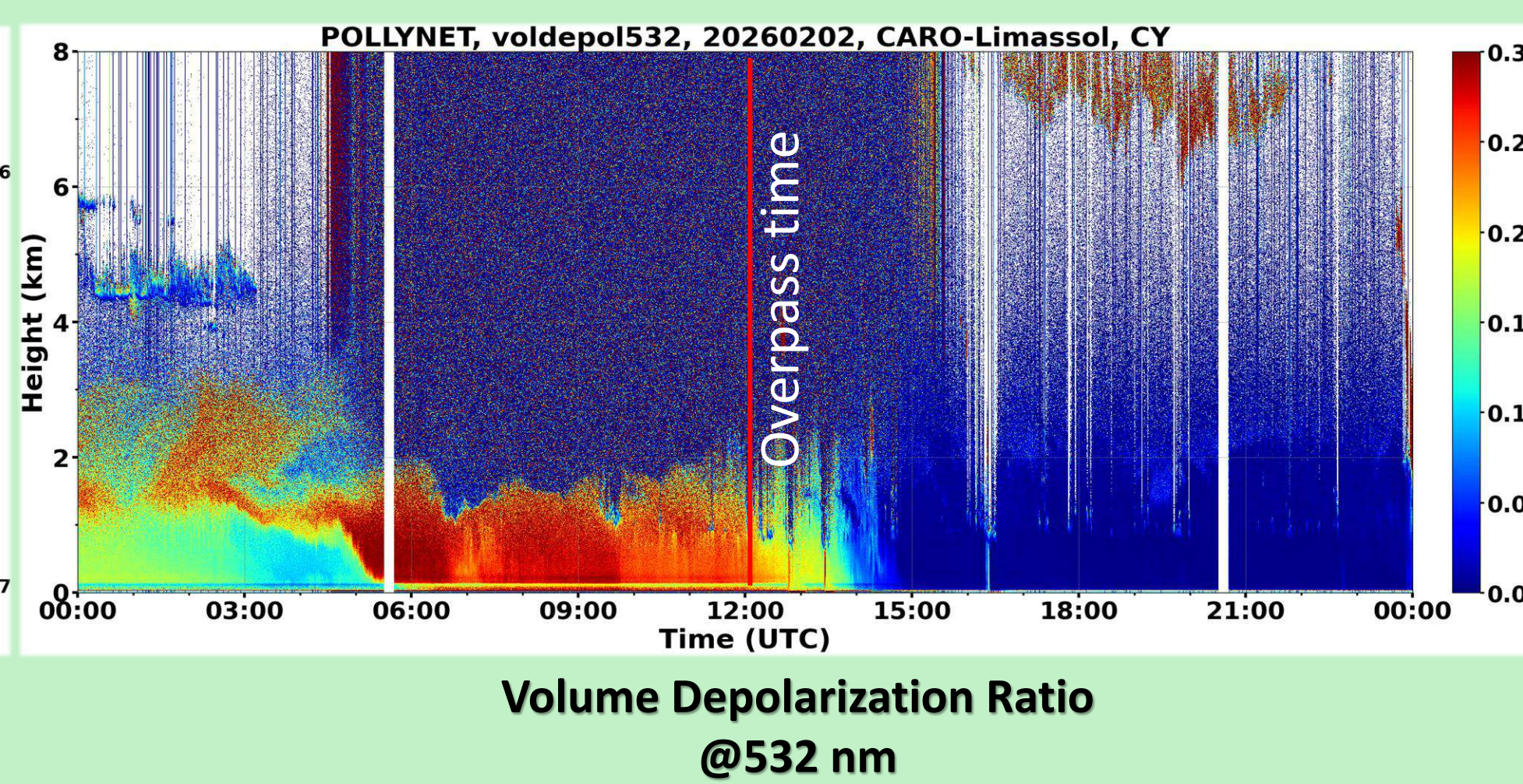
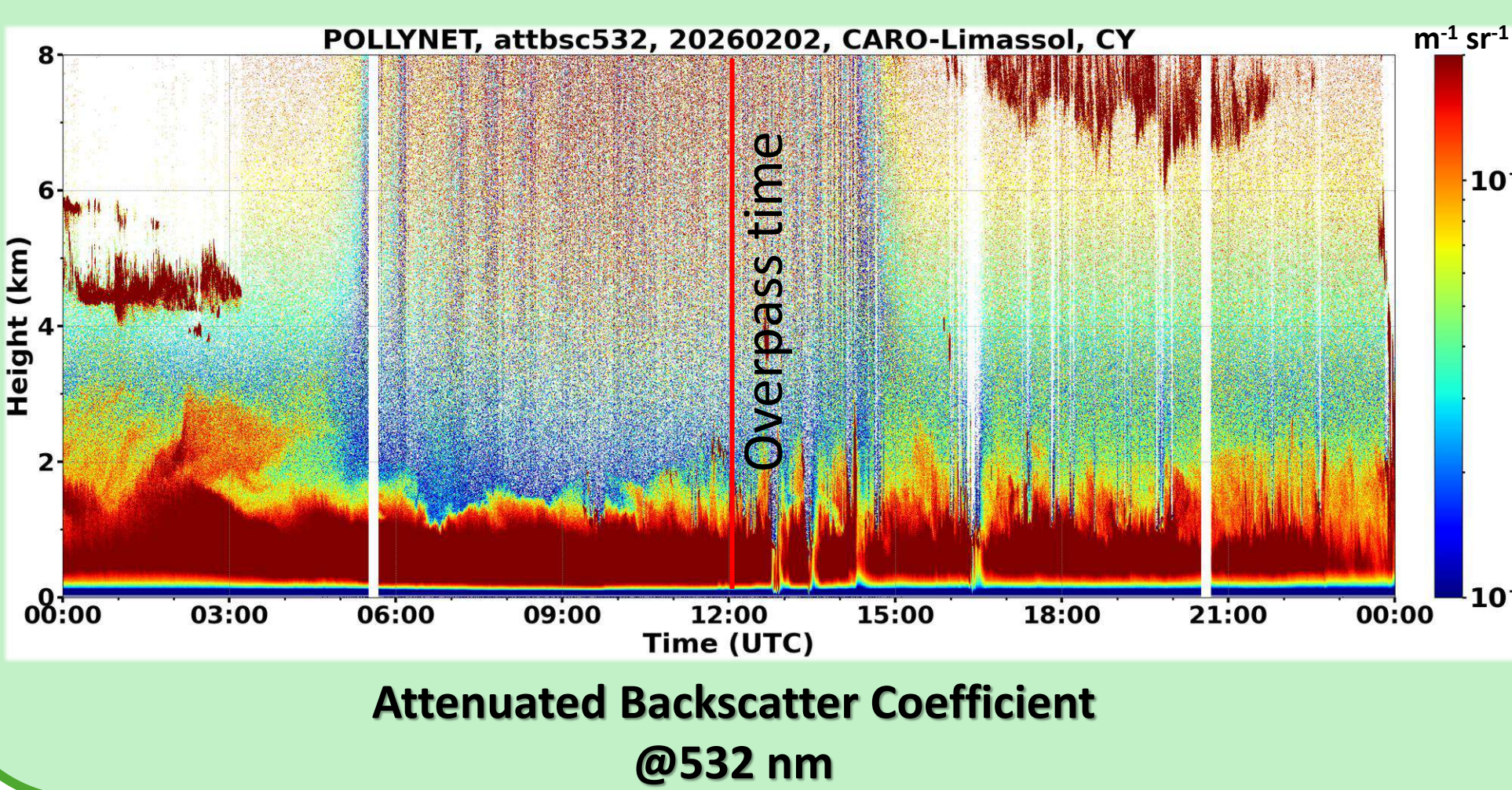
CARO National Facility

- ✓ Strategic Location: CARO is operated by the ERATOSTHENES Centre of Excellence in Limassol, Cyprus; positioned at the climatic crossroads of Europe, North Africa, and the Middle East.
- ✓ Synergistic Payload: Fully equipped ACTRIS National Facility featuring a Polly^{XT} Raman lidar, enabling direct comparisons with ATLID.
- ✓ Cal/Val Role: Actively participates in the cal/val activities through the CORAL EVID39 Cal/Val project by providing continuous, high-resolution vertical profiles of aerosols, clouds, and precipitation.
- ✓ Target Phenomena: Validates EarthCARE Level 2 products during complex regional events, like strong dust intrusions.

Cyprus Atmospheric Remote Sensing Observatory



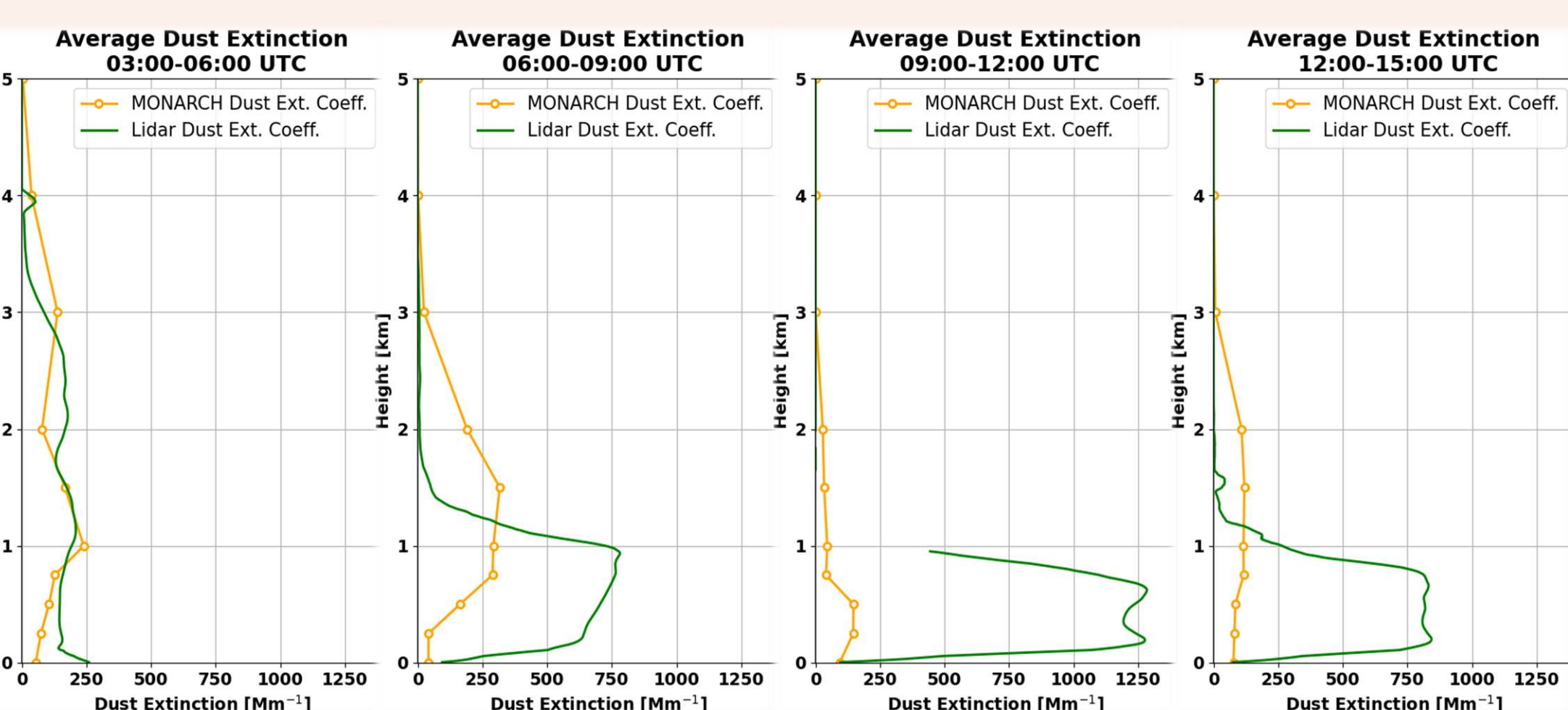
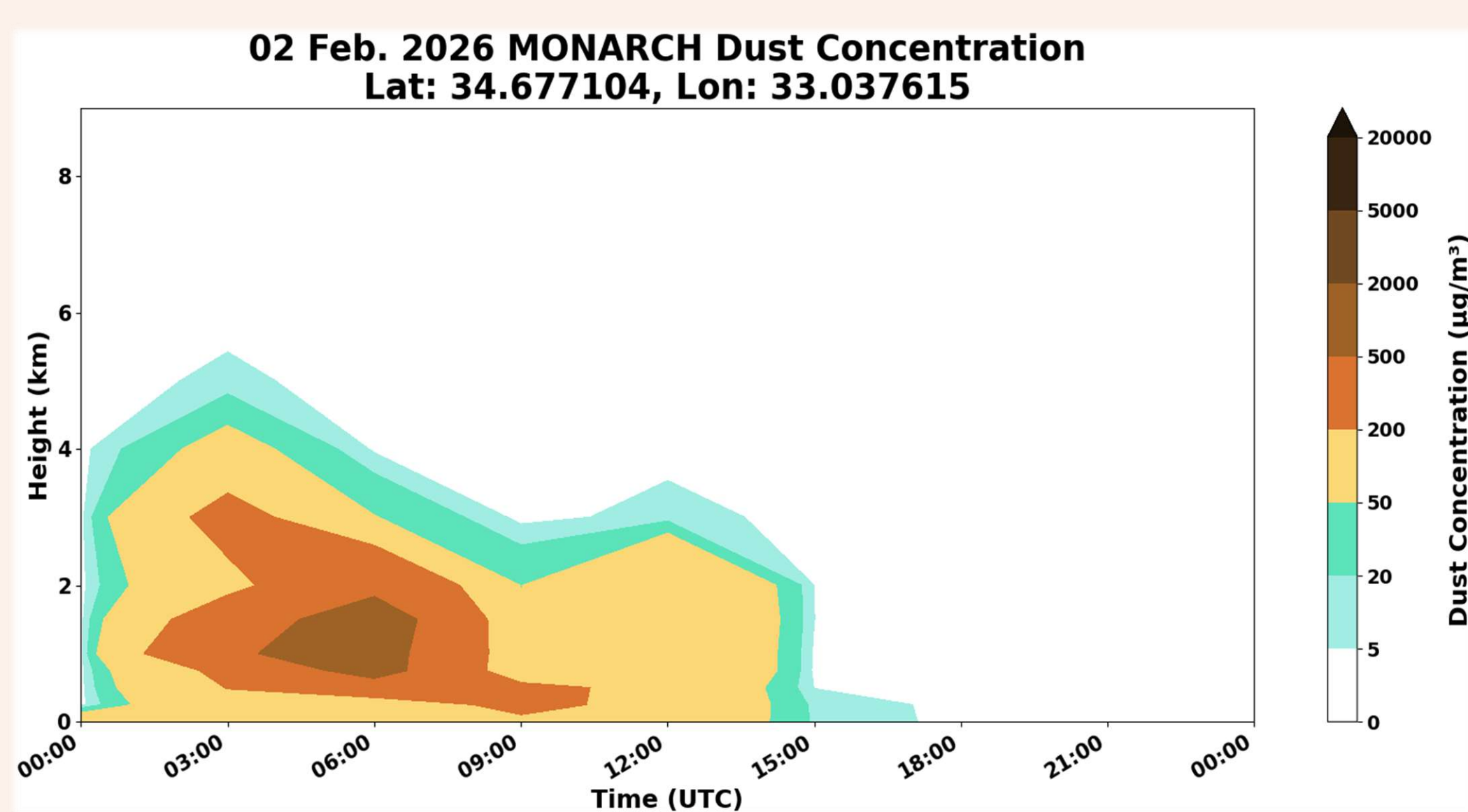
Dust case of 02 Feb. 2026



Ground-based Lidar

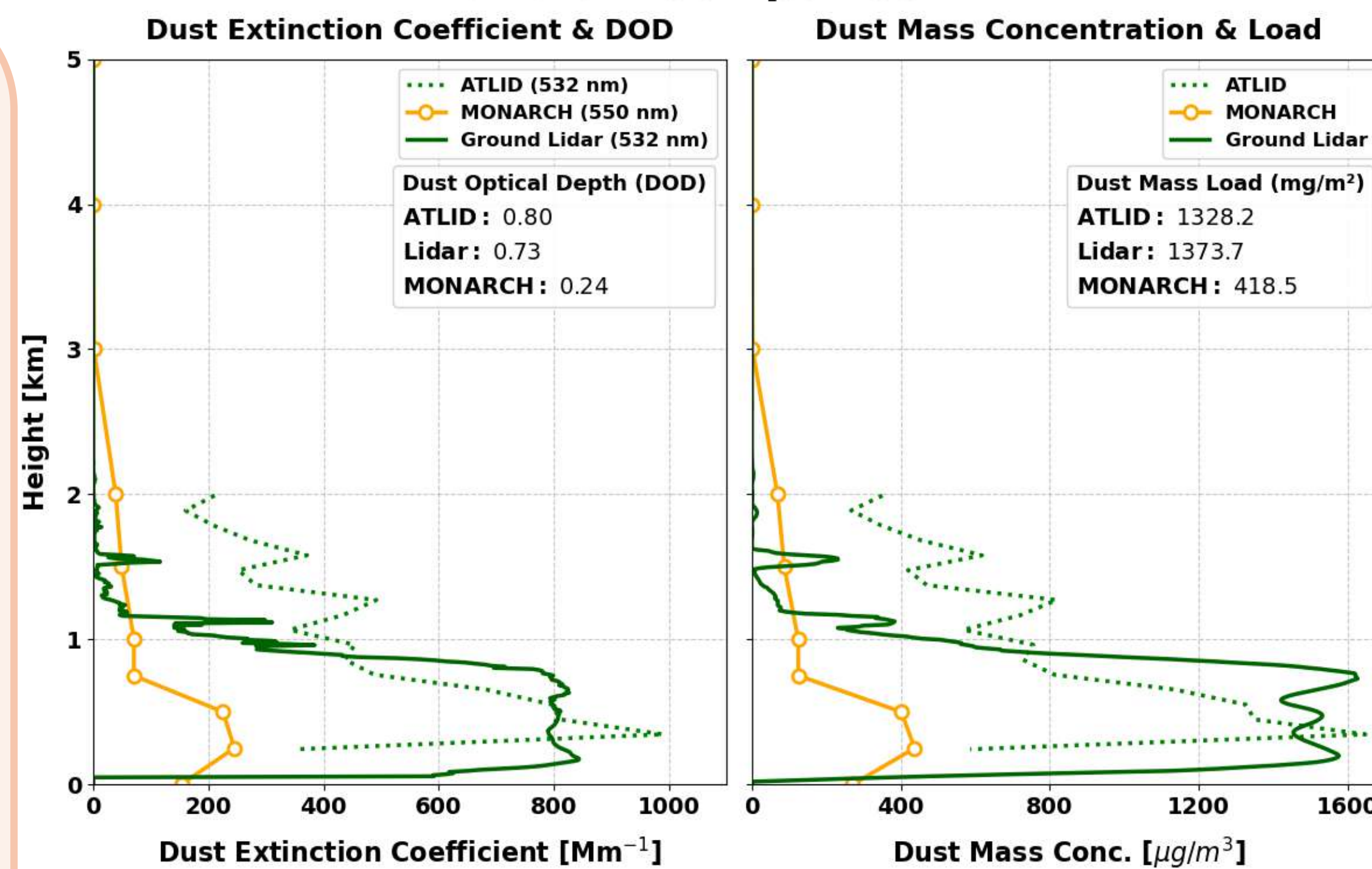


MONARCH Dust Forecast



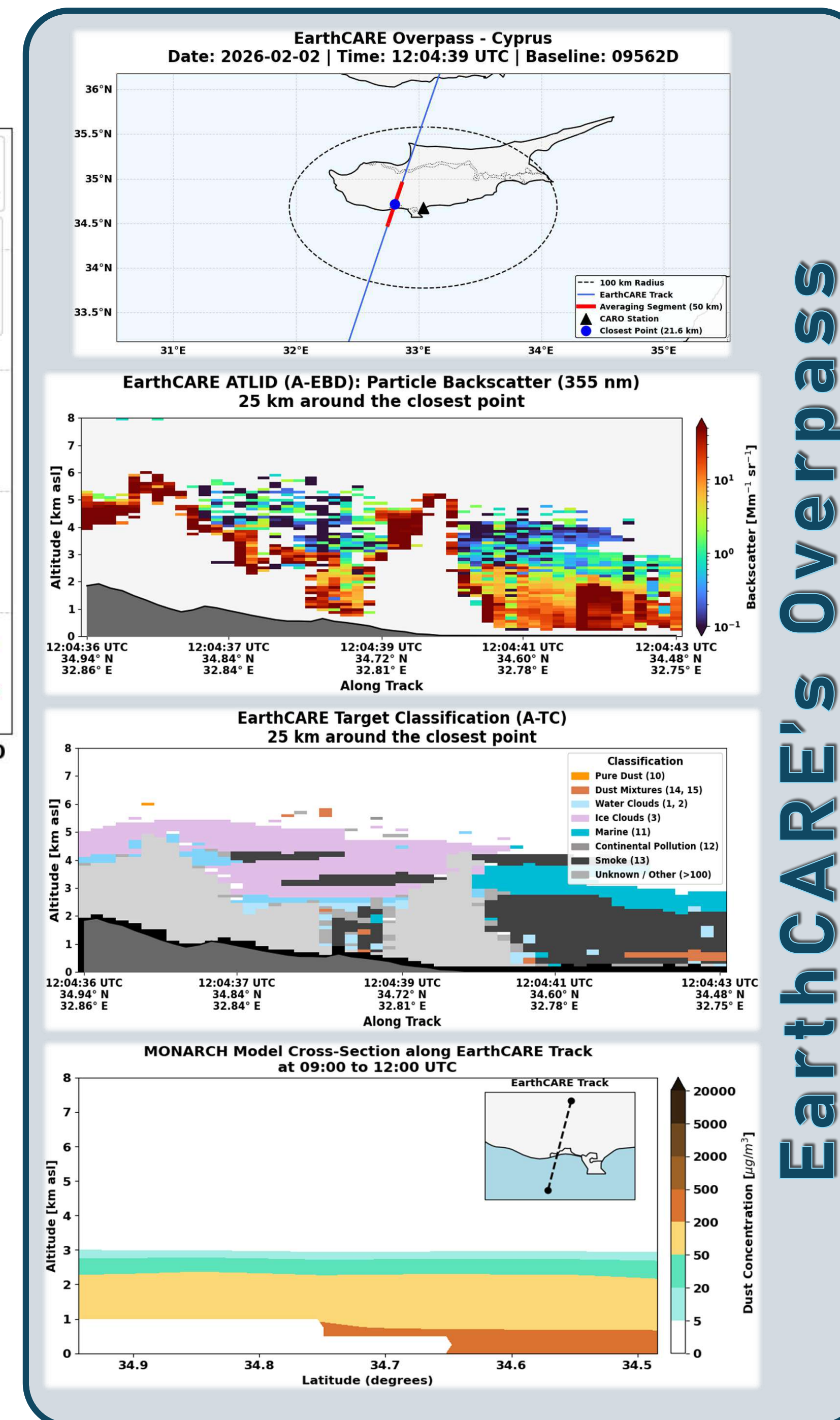
Dust Extinction Coefficient - Temporal Evolution

Overall Comparison



Conclusions

- **Observational Synergy:** EarthCARE and CARO lidar accurately captured the true magnitude and vertical structure of the extreme dust event.
- **Cal/Val Necessity:** EarthCARE partially misclassified dense dust as smoke, highlighting the critical need for ground-truth data to refine satellite algorithms.
- **Model Underestimation:** MONARCH captured only ~25% of the actual dust concentration.
- **Continuous Improvement:** These discrepancies underscore the essential role of ground-based feedback in improving both satellite retrievals and future forecasting accuracy.



EarthCARE's Overpass

This work was supported by the EXCELSIOR project that receives funding from the European Union's Horizon 2020 research and innovation programme under GA No 857510 and from the Government of the Republic of Cyprus through the Directorate General for the European Programmes, Coordination and Development and the Cyprus University of Technology. The authors also acknowledge the ATARRI Horizon Europe Widespread Twinning Project. ATARRI receives funding from the European Union's Horizon Europe Twinning Call (HORIZON-WIDERA-2023-ACCESS-02) under the GA No 101160258. The study has been implemented under the CORAL EVID39 CAL/VAL project.



EarthCARE 2026 Science and Validation workshop

8-12 June 2026 | Rhodes House | Oxford, UK