



Validation of EarthCARE MSI and ATLID aerosol products in Eastern Mediterranean using AERONET and CARO observations



EUROPEAN SPACE AGENCY

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Introduction

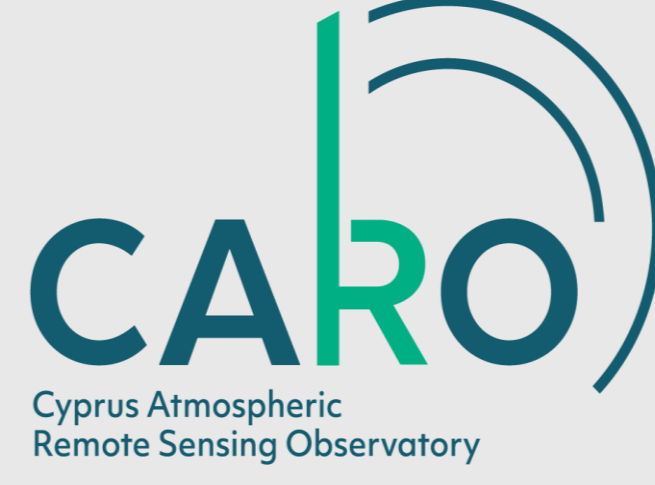
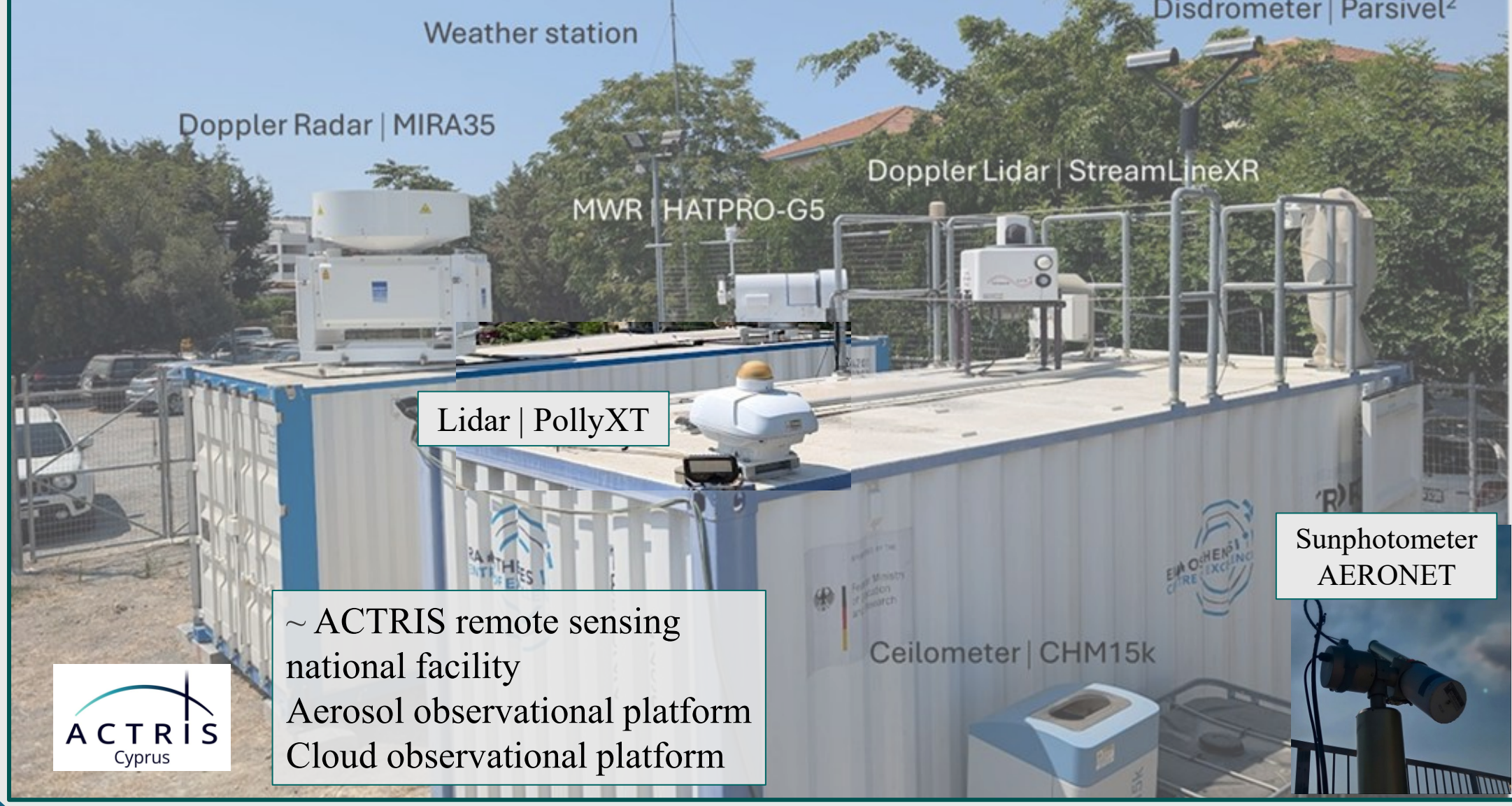
The assessment of spaceborne aerosol property retrievals is crucial for advancing atmospheric research, air-quality monitoring, and climate model-related applications. The ERATOSTHENES Centre of Excellence (ECoE), through the EXCELSIOR project, has established key research infrastructures in Limassol, Cyprus, including the Cyprus Atmospheric Remote Sensing Observatory (CARO), the ACTRIS National Facility. Through the ATARRI project, ECoE aims to maximize the use of these facilities to enhance atmospheric research, Earth observation, and modelling capabilities. The scope of this study is to validate EarthCARE MSI and ATLID aerosol products using ground-based measurements from a Cimel sunphotometer and PollyXT lidar at CARO and expanding the methodology to Eastern Mediterranean.

MSI Aerosol Optical Thickness Retrieval (M-AOT) Level 2A • Baseline BA
Validation Requirements
Diverse land and ocean scenes ~ Coastal region coverage

ATLID Extinction, Backscatter & Depolarization Retrieval (A-EBD) Level 2A • Baseline BA
Validation Requirements
Airborne lidar campaign measurements ~ Ground-based lidar network observations

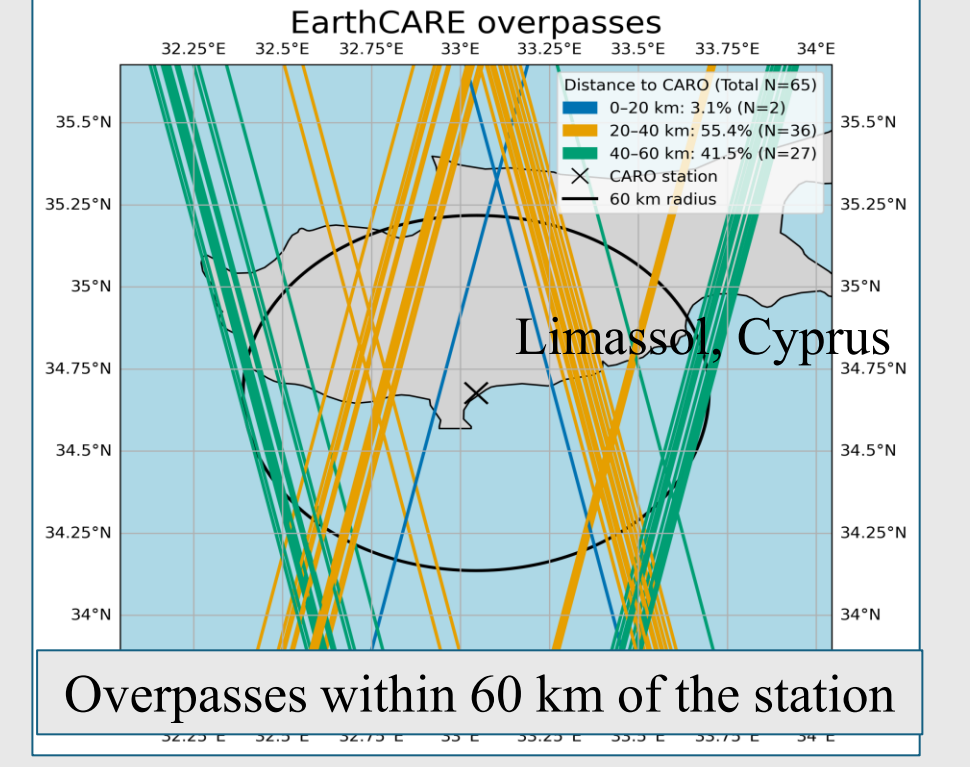
Reference Data – Cyprus Atmospheric Remote sensing Observatory

Ground-based data: Lidar and Sunphotometer



PollyXT (Raman Polarization Lidar)

- Multiwavelength (355, 532, and 1064 nm), dual-FOV Raman lidar operating continuously in Limassol since 2020.
- Part of PollyNET, a global network of automated lidars for continuous aerosol profiling.
- Products used:** Extinction at 355 & 532 nm



Sunphotometer (AERONET CE318)

- Ground-based sun photometer operating in Limassol since 2010, providing daytime aerosol observations, including aerosol optical depth (AOD).
- Part of AERONET, a global network delivering standardized, quality-assured aerosol data for research and satellite validation.
- Products used (level 1.5):** AOD_675nm, AOD_340nm, 440-675_Angstrom_Exponent, 340-440_Angstrom_Exponent

Methodology

DATA SOURCES



PREPROCESSING & HARMONIZATION

- Ångström exponent (AERONET) used for wavelength conversion of ground-based measurements

$$AOT(\lambda) = AOT(\lambda_0) \times \left(\frac{\lambda}{\lambda_0}\right)^{-\alpha}$$

DATA PROCESSING OPTIMIZATION

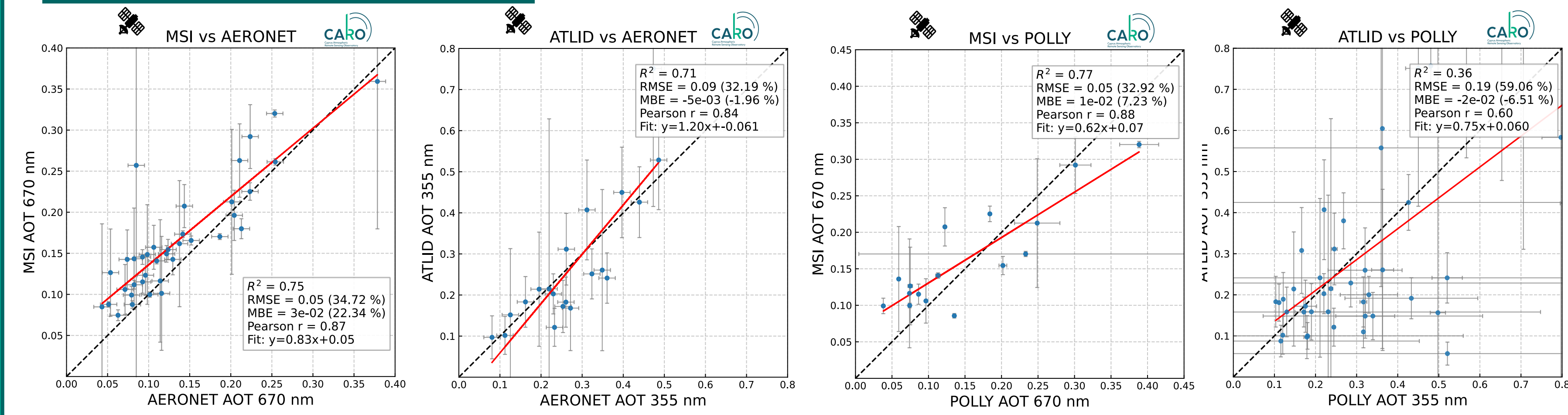
MSI < 60 km	ATLID CP	AERONET ±30 min	Polly ±30 min
Spatial averaging, radii from station: • 50 km, 60 km, 100 km	• Closest Point Spatial averaging from CP: • ±25 km • ±50 km	Temporal averaging: • ±30 minutes • ±1 hour • ±2 hours	Temporal averaging: • ±30 minutes • ±1 hour
LIDARS • Extinction integration up to 10 & 12 km -> AOT • BEST: 10 km			

COMPARISONS



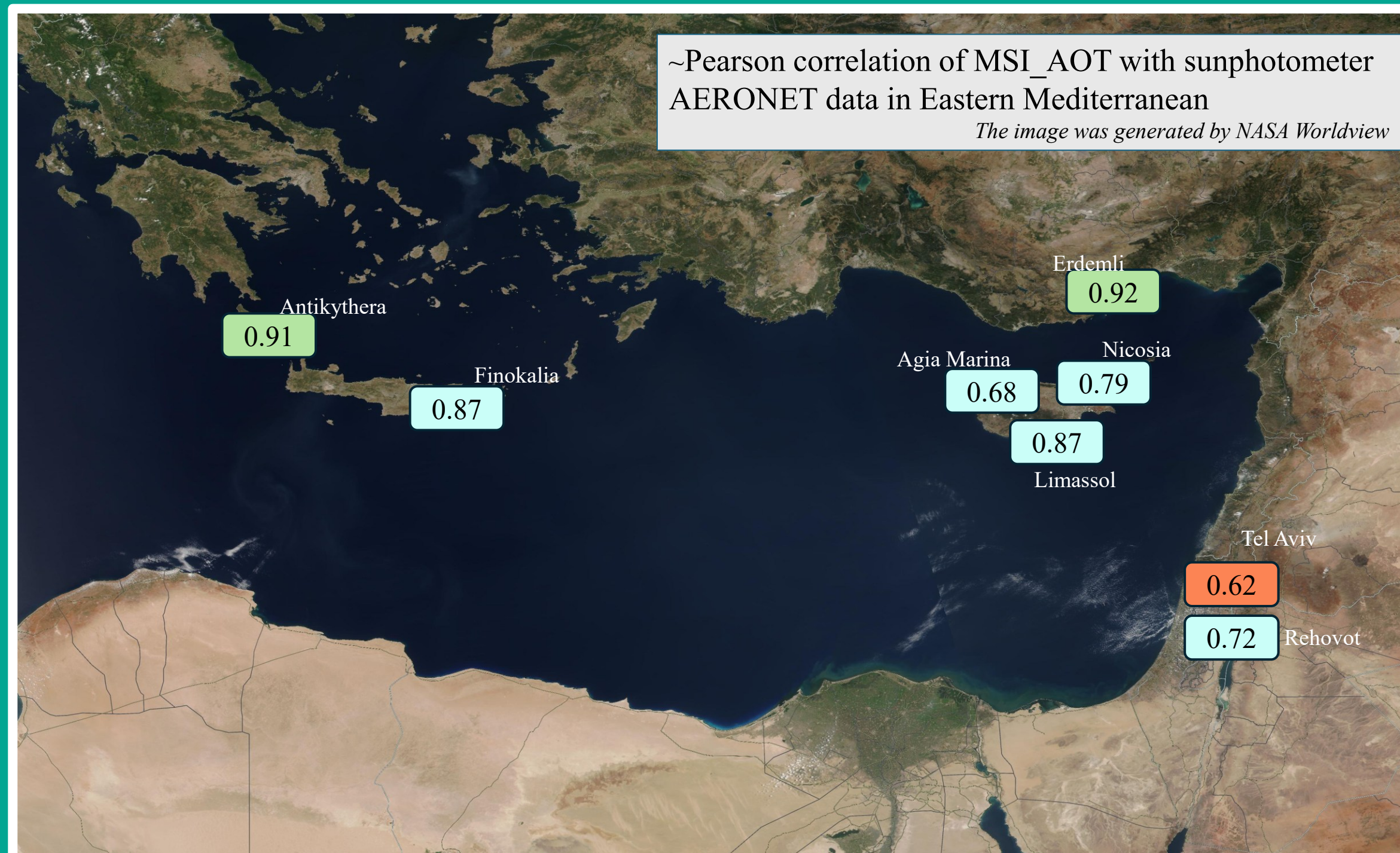
Satellite and ground-based observations are compared using linear regression on scatter plots.
Statistical metrics: R², RMSE, MBE, Pearson correlation (r)

First results



- Best results for: MSI: 60 km, ATLID: closest overpass point with integration up to 10 km, AERONET/PollyXT: ±30 min.
- MSI-AERONET shows the strongest correlation, though with a slight AOT overestimation by MSI.

Expanding Methodology to Eastern Mediterranean

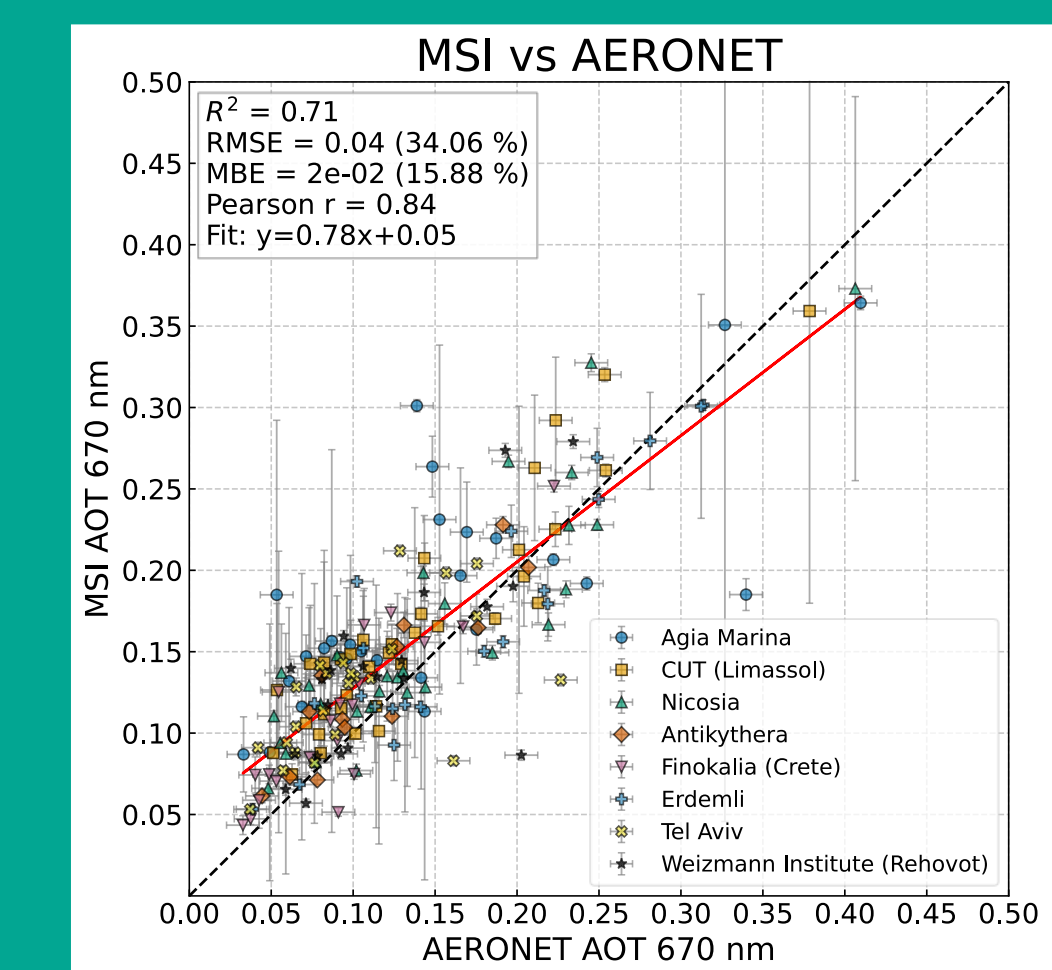


Within a 60 km radius of station coverage, the proportion of sea area seems to influence the correlation: stations in regions with greater sea coverage tend to show stronger correlations.



A global network of ground-based aerosol monitoring stations with sunphotometers (Data used: level 1.5 (cloud-screened))

MSI vs AERONET



Conclusion

The strong validation of MSI and ATLID aerosol retrievals against ground-based aerosol measurements demonstrates their readiness to contribute to EarthCARE's core objectives. Especially, MSI_AOT_2A has been shown to be reliable and can be used with confidence, despite slight overestimations at lower AOT levels.

Future work:

~Expand datasets with more data

~Implement method for latest baselines

Acknowledgments

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