

S. Nicolae^{1,2}, G. Ciocan^{1,3}, M. Tirlea¹, L. Belegante¹, A.M. Dandocsi¹

¹National Institute of R&D for Optoelectronics INOE2000, Magurele, Ilfov, Romania

²Doctoral School of Electronics, Telecommunications and Information Technology, National University of Science and Technology "Politehnica" Bucharest, Bucharest, Romania

³Faculty of Physics, University of Bucharest, Bucharest, Romania

Objective

Analyze overpass-distance-dependent correlation and statistical metrics between the ATLID instrument of the EarthCARE satellite and ground-based lidars from the EARLINET network, with a focus on characterizing and analyzing vertical difference patterns between the two sources of data.

Datasets

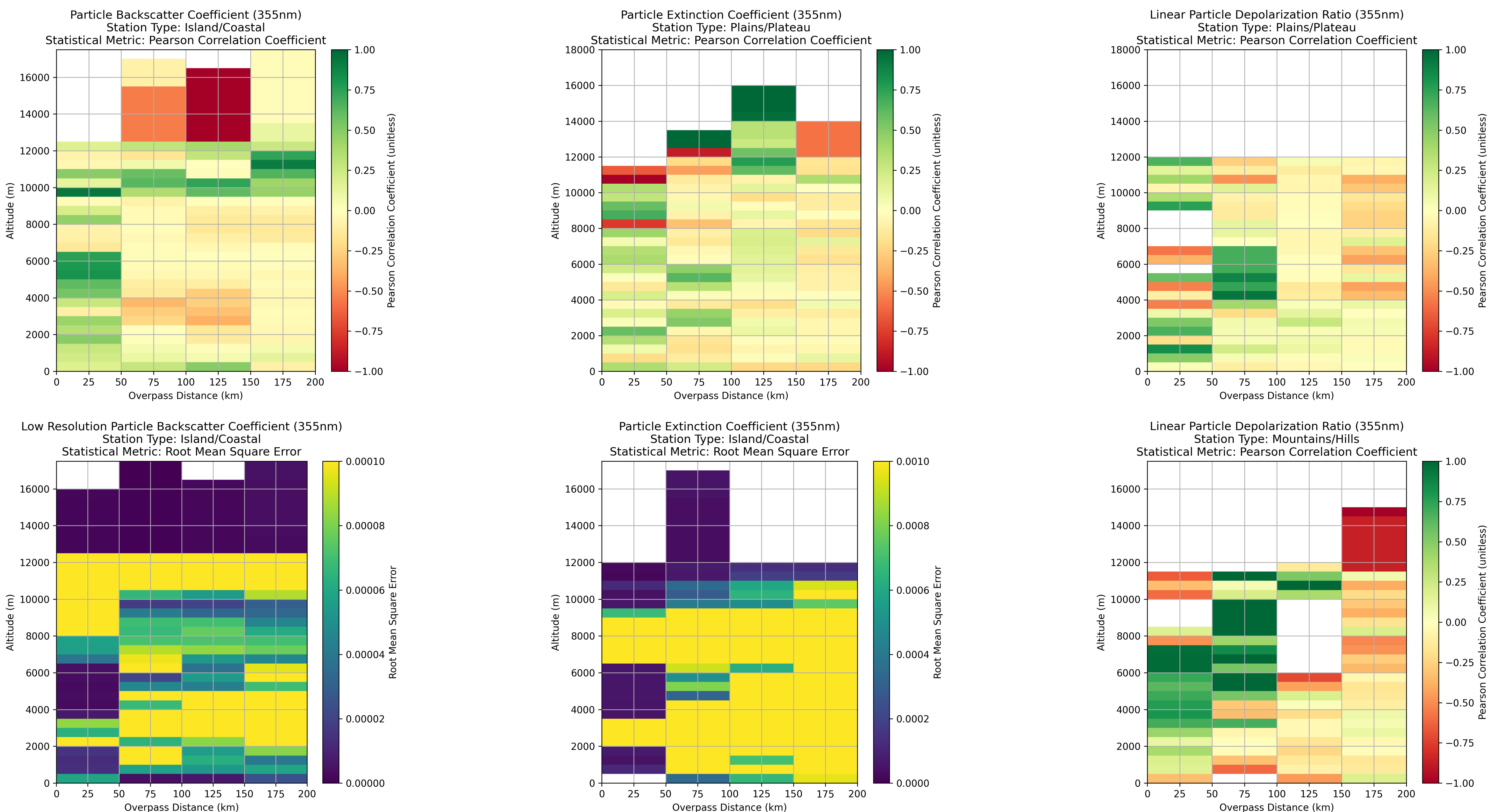
The datasets used include the publicly available EarthCARE L2A EBD dataset [1] and the publicly available EARLINET dataset [2]. The EARLINET dataset has been subset to include only stations which can measure at a wavelength of 355nm, in order to match ATLID's native measurement wavelength [3].

Methodology

1. Data gathering and acquisition: Harvest the publicly available EARLINET and EarthCARE L2A EBD (baseline \geq EXBA) databases for valid data. For this, a custom Python utility was developed, which can automatically search for overpasses of EARLINET stations.
2. Temporal and spatial collocation: Filter the data to ± 1 hr of overpass time, and variable overpass distance of up to 200km.
3. Data curation and filtering: Filter EarthCARE data according to the best quality criteria (*qa_value* and *extended_qa_value* variables) and filter both datasets to be physically plausible (non-negative values for the 3 studied variables: particle backscatter coefficient, particle extinction coefficient, particle linear depolarization ratio). Very noisy measurement bins (error bar $>$ value) were filtered from both datasets as well.
4. Split the data: Group the data according to the geographical localization of the corresponding EARLINET station – three main categories were chosen: Island/Coastal, Plains/Plateau and Mountains/Hills
5. Data processing: Rebin the measurements while preserving the total column amounts on a common linearly-spaced 500m grid
6. Analysis: Compute relevant metrics (Pearson R, RMSE, Relative Bias) against the overpass distance, for each case of different altitudes and station types.

Results and Analysis

Results show a reasonable agreement between the ground-based lidar network and the EarthCARE measurements, particularly for the backscatter and extinction variables. However, we see a much better agreement for the particle extinction coefficient in the UTLS (Upper Troposphere Lower Stratosphere) than for the FT (Free Troposphere), especially for higher overpass distances. This is explained by the more stable and homogenous upper layers present in the UTLS as compared to the FT. Furthermore, linear particle depolarization ratio results show high variance and is not always in good agreement with the ground-based lidars, possibly stemming from the lower amount of data points available and the noisy EarthCARE high resolution L2A EBD profiles. Furthermore, a strong dependency on the overpass distance used for filtering is seen for the particle linear depolarization ratio, particularly over highly variable terrain (Mountains/Hills station types).



References

- [1] European Space Agency, 2025, "EarthCARE ATLID ALD Level 2A", (version BA), <https://doi.org/10.57780/eca-ad34adb>
- [2] European Aerosol Research Lidar Network, 2026, "EARLINET Data Portal", (version 2026), <https://data.earlinet.org>
- [3] European Space Agency, 2016, "EarthCARE ATLID Level 1 Processor Algorithm Theoretical Basis Overview (ATBO)", (version 6.1), <https://earth.esa.int/eogateway/documents/20142/37627/EarthCARE-ATLID-L1-ATBO.pdf>

Acknowledgments

This work was financed by the Core Program within the Romanian National Research Development and Innovation Plan 2022-2027, carried out with the support of MCID, project no. PN 23-05, and the ESA project DIVA, contract 4000121773/17/I-EF, and the AECARE (ACTRIS for EarthCARE L2 product evaluation) project. The authors utilized data from the ESA EarthCARE ATLID EBD Level 2A (version BA). The authors wish to acknowledge ACTRIS for its essential role in providing access to highquality data, facilities, and technical support that were integral to the execution of this research. The authors gratefully acknowledge the EARLINET and ACTRIS units for the data collection, calibration, processing, and dissemination. The authors