Evaluation of the EarthCARE aerosol classification scheme using ACTRIS/EARLINET observations

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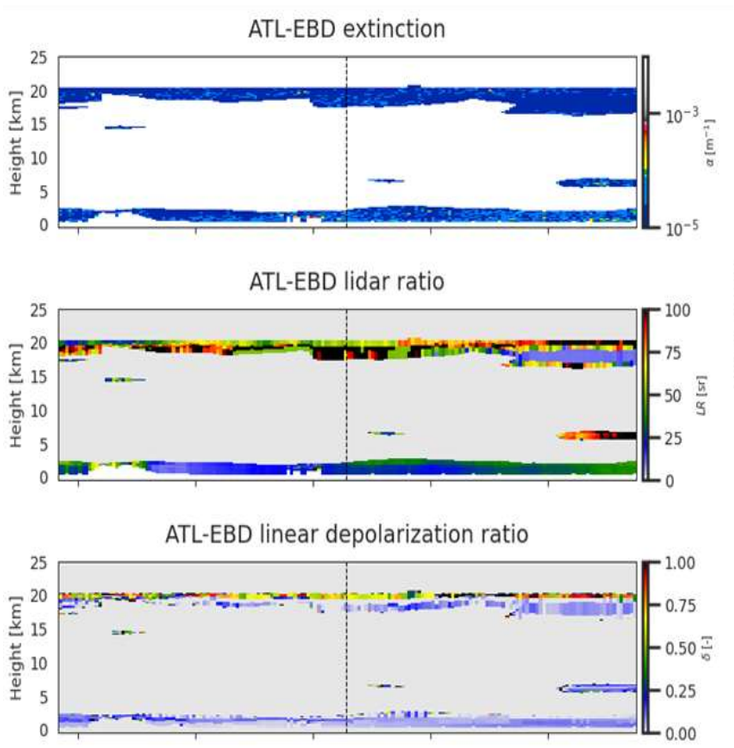
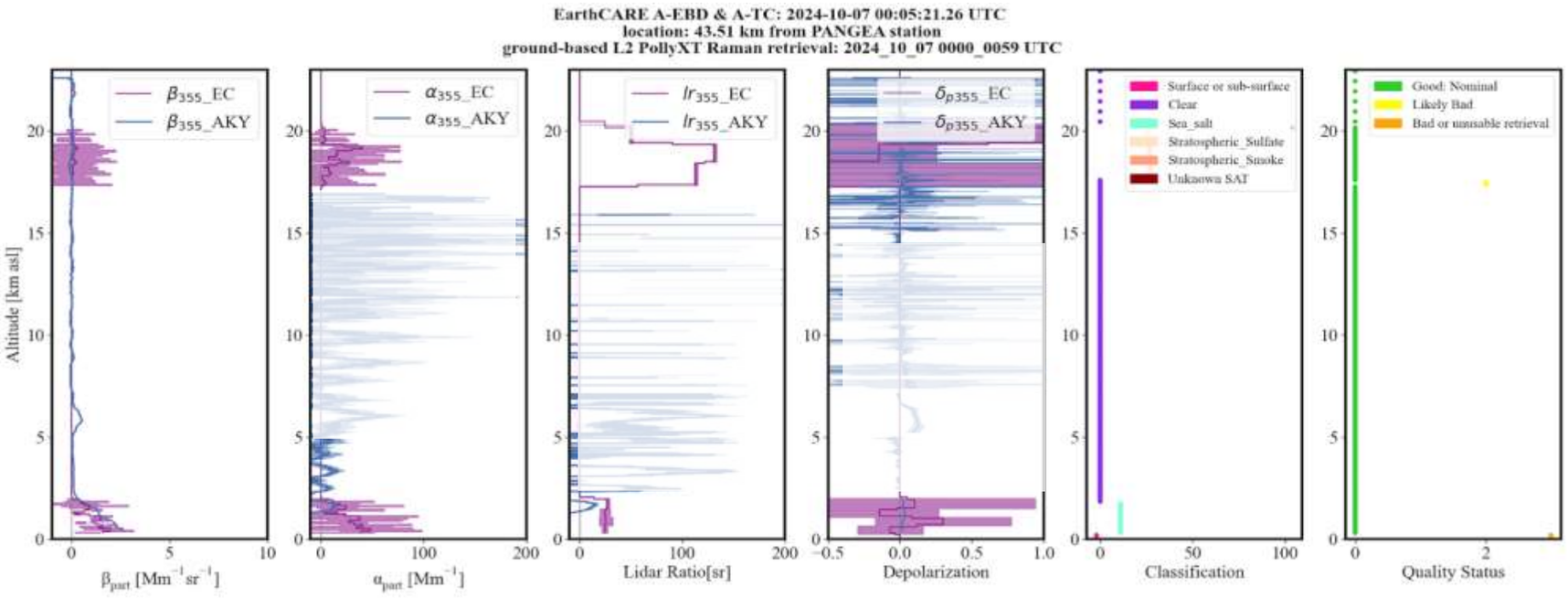
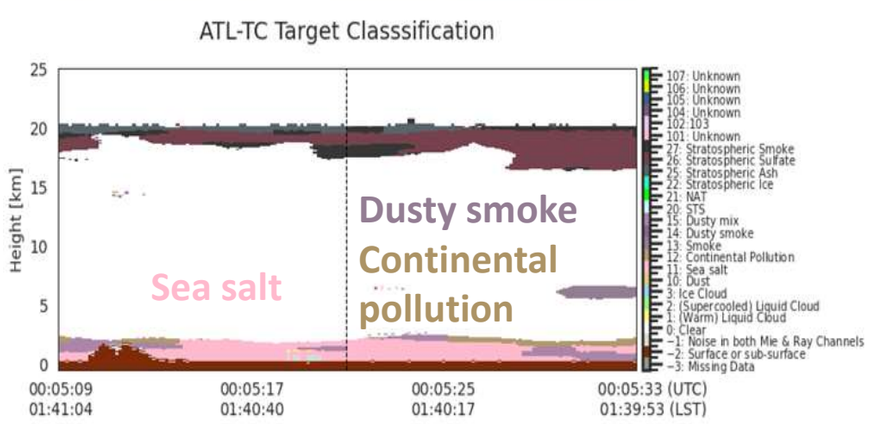
In this study we select cases with complex atmospheric conditions to evaluate the Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) aerosol classification scheme (Wandinger et al., 2023) by comparing its performance with the ACTRIS/EARLINET dataset and the predominant aerosol types identified by the different algorithms developed within them.

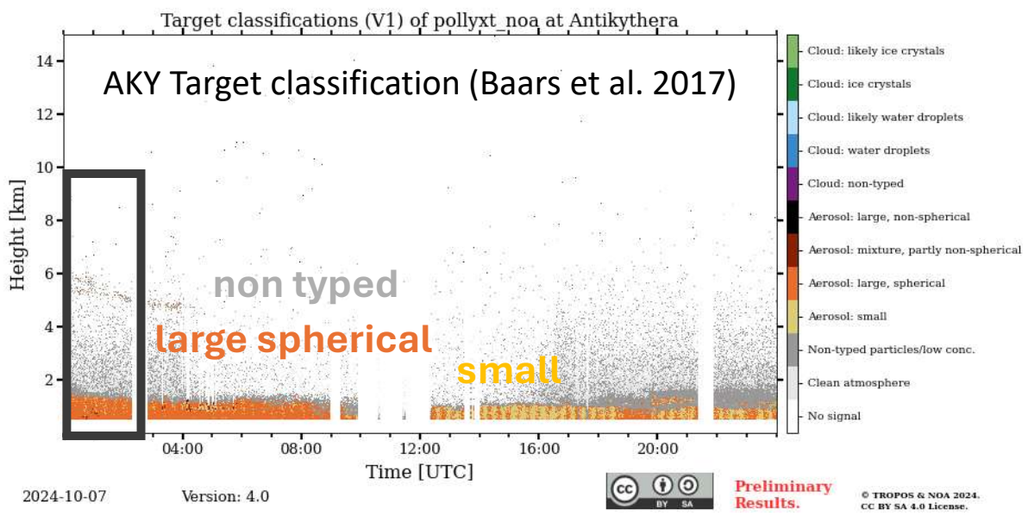
- The Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) is a joint mission of the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) mission equipped with four sensors, a cloud-profiling radar (CPR), a high-spectral-resolution cloud–aerosol lidar (ATLID), a cloud–aerosol multi-spectral imager (MSI), and a three-view broad-band radiometer (BBR). The three instruments, i.e., ATLID, MSI, and BBR, provide information on global aerosol distribution and contribute to the overarching EarthCARE goals of sensor synergy and radiation closure with respect to **aerosol presence**.
- ACTRIS (Aerosol, Clouds and Trace Gases Research Infrastructure) / EARLINET (European Aerosol Research Lidar Network) database (Pappalardo et al., 2014; data.earlinet.org) includes backscatter, extinction, lidar ratio, and particle depolarization ratio profiles over more than 33 stations over Europe.
- 11 stations are included in this evaluation: *AKY, POT, LEI, INO, CBW, THE, GRA, RUN, PUY, BRC, NCS, KUO*
- This database has been used for developing aerosol typing algorithms (Nicolae et al., 2018; Papagiannopoulos et al., 2018; Floutsi et al., 2023; 2024).
- Intensive optical properties are concentration-independent parameters which reveal information about the aerosol type.
- The most common intensive optical parameters used for **aerosol-typing** purposes are the *LR*, the *particle depolarization ratio*, and the *Ångström exponent*. These parameters are common **L2** products.

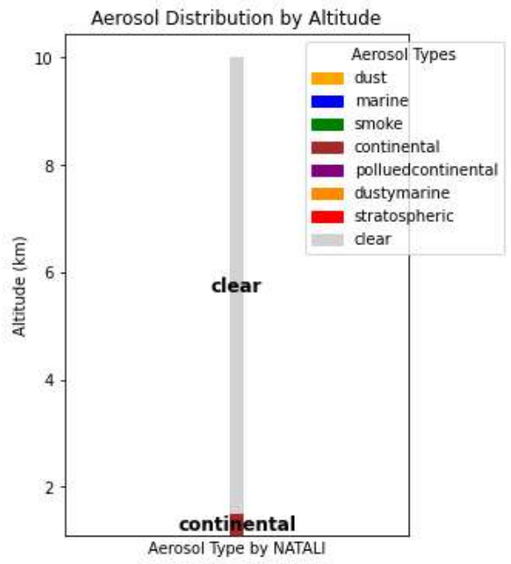
Case study











Layer <2km: EC mainly Sea salt, + parts continental pollution & dusty smoke
AKY mainly large spherical, + parts small & non typed / continental

Key points for validating the EarthCARE aerosol classification scheme, aligned with the Best Practice Protocol for the validation of Aerosol, Cloud, and Precipitation Profiles (ACPPV) project (https://zenodo.org/records/15025627)

- ❑ Consistency must be ensured for the atmospheric layer geometrical boundaries (wavelength/derivative method, etc.,).
- ❑ A first step towards the classification validation is the validation of the L2 products that were used in the classification scheme. This will provide valuable information on misclassification reasons.
- ❑ Intercomparison with a different aerosol typing scheme that uses the same (or different) L2 input parameters can be applied. However, this becomes difficult due to the different nomenclatures and classifications used in the different aerosol typing schemes (Voudouri et al., 2019).
- ❑ Since aerosol typing is usually applied to atmospheric features, a consistency check between the feature identification algorithms shall be performed.

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