# POLIPHON implementation in the *earthcarekit* software tool: micro-physical and cloud-relevant aerosol properties from EarthCARE/ATLID

Leonard König[1], Julian Hofer[1*], Holger Baars[1], Moritz Haarig[1], Athena A. Floutsi[1], Edward Malina[2], Daniele Gasbarra[2], Albert Ansmann[1], and Ulla Wandinger[1]

[1]Leibniz Institute for Tropospheric Research, Leipzig, Germany

[2]European Space Agency (ESA), European Space Research Institute (ESRIN), Frascati, Italy

***contact: julian.hofer@tropos.de**

## POLIPHON method

### Polarization Lidar Photometer Networking (POLIPHON)

**Goal:** Global studies on aerosol-cloud interaction using EarthCARE/ATLID observations (Wehr et al., 2023).

**Need:** Vertical profile estimates of microphysical and cloud-relevant aerosol properties (e.g., cloud condensation nuclei (CCN), ice-nucleating particles (INP)) from EarthCARE/ATLID products (e.g., Donovan et al., 2024).

**Approach:** Implement POLIPHON (Fig. 1a) for 355 nm wavelength. Retrieve extinction-to-microphysics conversion factors (Ansmann et al., 2026; Hofer et al., 2026) from regression analyses (e.g., Fig. 1b) of long-term AERONET (Aerosol Robotic Network) retrieved particle size distributions (e.g., Dubovik et al., 2006).

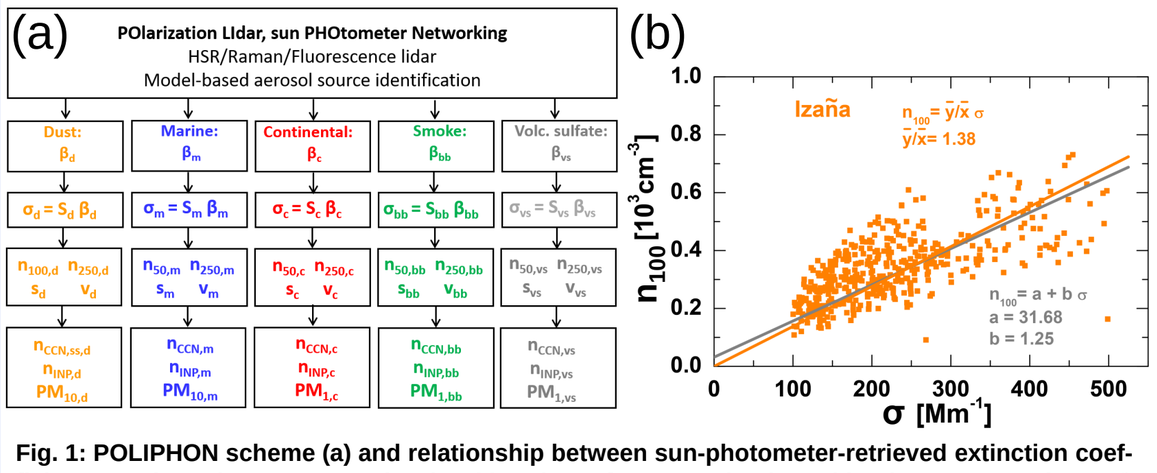


**Fig. 1: POLIPHON scheme (a) and relationship between sun-photometer-retrieved extinction coefficient σ and number concentration (r>100 nm) $n_{100}$ for cases dominated by dust measured at Izaña, Tenerife, AERONET station (b) (Ansmann et al., 2026).**

## POLIPHON@*earthcarekit*

### POLIPHON implementation in the *earthcarekit* software tool

POLIPHON was implemented in *earthcarekit,* a software tool developed at TROPOS, that provides comprehensive and flexible tools for downloading, reading, analyzing, and visualizing EarthCARE data (König et al., 2026).

As an open-source python package, it can be used as a resource in portals like ESA's MAAP (Multi-mission Algorithm and Analysis Platform) or EarthCODE.

The POLIPHON implementation in the *earthcarekit* repository (https://github.com/TROPOS-RSD/earthcarekit, last access: 18 May 2026) is to date still in private mode for testing and validation purposes. Access can be granted on request.

Documentation:

https://pypi.org/project/earthcarekit/ (last access: 18 May 2026)

EarthCODE https://earthcode.esa.int/ (last access: 18 May 2026)

ESAMAAP https://portal.maap.eo.esa.int/ (last access: 18 May 2026)

## Applications

### INP estimates from EarthCARE/ATLID using POLIPHON

Apply POLIPHON on A-EBD and A-TC (baseline BA, low resolution, Fig. 2) using the 355-nm conversion factors (Ansmann et al., 2026; Hofer et al., 2026).

Retrieve dust number, surface area, and INP concentration estimates (Fig. 3).

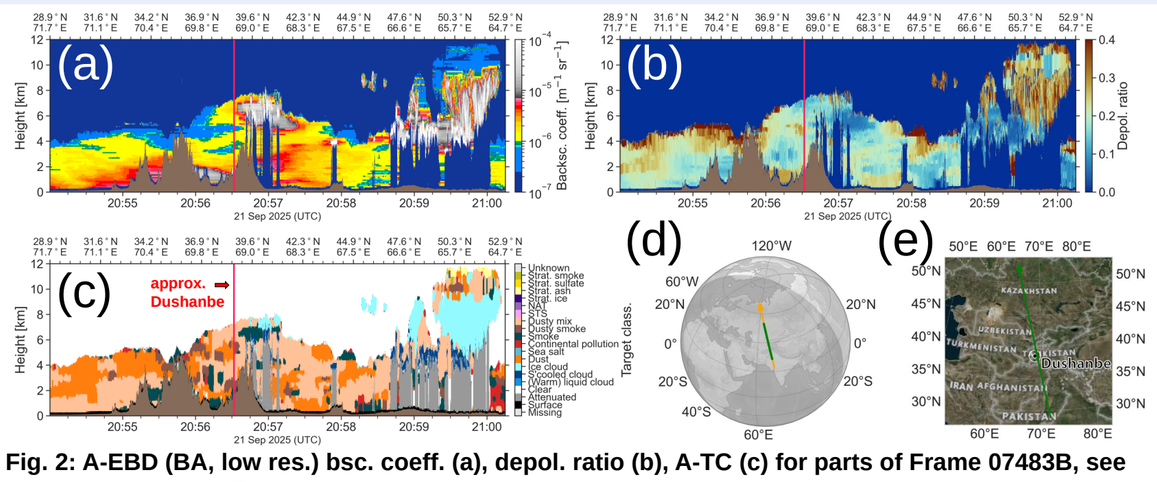


**Fig. 2: A-EBD (BA, low res.) bsc. coeff. (a), depol. ratio (b), A-TC (c) for parts of Frame 07483B, see groundtracks (d,e). The surface elevation is depicted in brown and the ground-station with a red bar.**

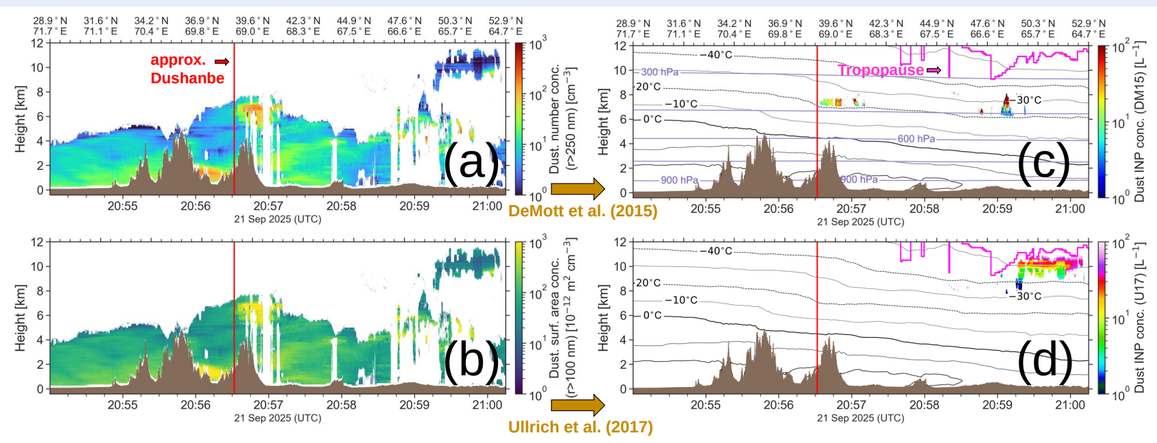


**Fig. 3: Dust number (a) and surf. area conc. estimates (b) from POLIPHON using 355-nm conversion factors, A-EBD bsc. coeff., depol. ratio, and A-TC dust, dusty smoke, dusty mix, and smoke pixels. Dust INP conc. estimates (c,d) retrieved by applying different parameterizations on (a) and (b), using X-MET (baseline BC) temperature and pressure. The tropopause is depicted with a magenta line.**

### Comparison to ground-based lidar observations

Ground-based obs. with multiwavelength polarization Raman lidar PollyXT at Dushanbe, Tajikistan (38.5N, 68.5E, 864 m a.s.l.; Engelmann et al., 2019).

21 Sep. 2025, 20:00–21:30 UTC during EarthCARE overpass: mixed dust scene; pure dust close to the ground (missed by ATLID due to topography); POLIPHON separation into smoke and dust (according to A-TC; Fig. 2c) (Fig. 4).

Retrieval of dust and smoke surface area concentration profile estimates using suborbital and ATLID measurements (Fig. 4e,f).

Surface area concentrations serve as input in INP parameterizations (e.g., Ansmann et al., 2021).

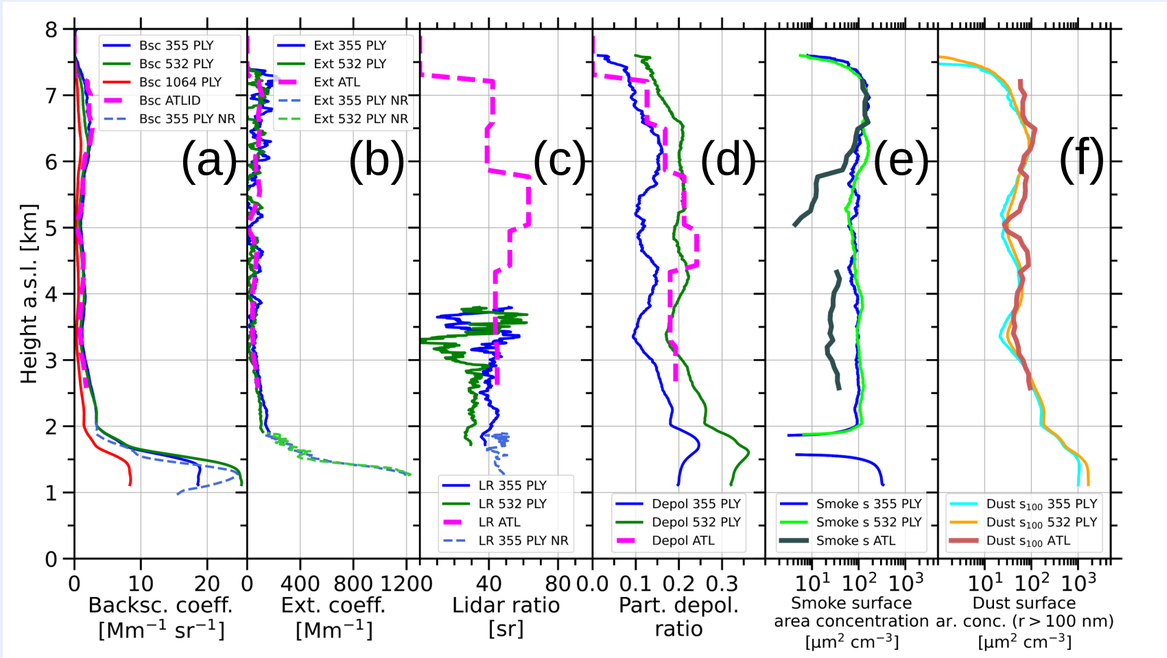


**Fig. 4: Aerosol optical properties (a–d) from PollyXT at Dushanbe, Tajikistan, averaged during 21 Sep. 2025, 20:00–21:30 UTC and from A-EBD (baseline BA, low res.) at 20:56:31.7, 38.63N/69.30E (dashed magenta), and smoke (e) and dust surf. area conc. estimates (f) from POLIPHON using 355- and 532-nm aerosol optical properties and conversion factors, respectively. Uncertainties range from 10% (backscatter coefficient) to 30% (surface area concentration) (Ansmann et al., 2026).**

## References and acknowledgments

**References:** Ansmann et al., 2021 (https://doi.org/10.5194/acp-21-9779-2021); Ansmann et al., 2026 (https://doi.org/10.5194/egusphere-2026-648, accepted); Donovan et al., 2024 (https://doi.org/10.5194/amt-17-5301-2024); DeMott et al., 2015 (https://doi.org/10.5194/acp-15-393-2015), Dubovik et al., 2006 (https://doi.org/10.1029/2005JD006619); Engelmann et al., 2019 (https://doi.org/10.1051/e3sconf/20199902010); Hofer et al., 2026, (https://doi.org/10.5281/zenodo.18346577, dataset); König et al., 2026 (https://doi.org/10.5281/zenodo.16813294, software); Ullrich et al., 2017 (https://doi.org/10.1175/JAS-D-16-0074.1); Wehr et al., 2023 (https://doi.org/10.5194/amt-16-3581-2023)

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## Outlook

Implementation of stratospheric aerosol types (particularly stratospheric smoke).

Implementation of time-dependent INP parameterizations (Ansmann et al., 2021).

Retrieve global dataset of microphysical and cloud-relevant aerosol properties.

Utilize such a dataset for global aerosol-cloud-interaction studies.