ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

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From HETEAC to HETEAC-Flex and beyond- algorithm developments in preparation for EarthCARE

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Outline

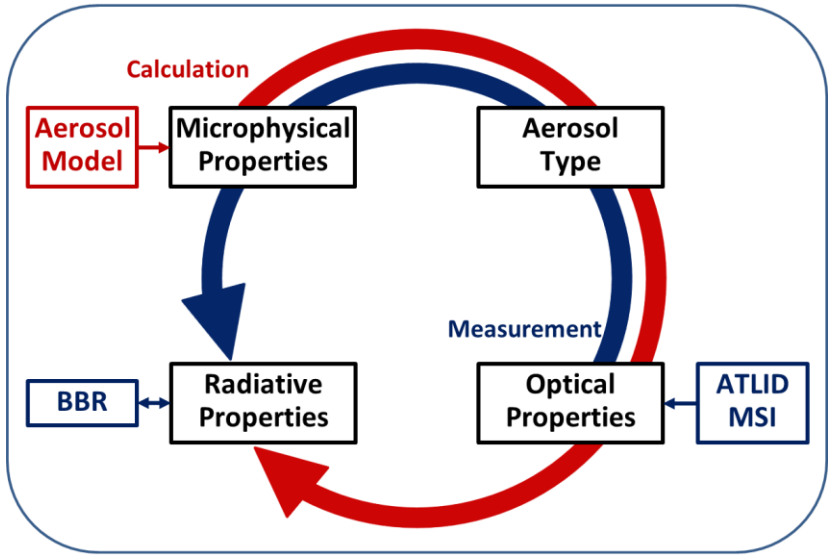
- HETEAC
- HETEAC-Flex
- Applications
- Summary & Outlook

Hybrid End-To-End Aerosol Classification HETEAC

Goal: **Radiation closure** for 100 km^2 within 10 Wm^{-2}

1. Proper aerosol classification based on the ATLID observations

2. An aerosol model that connects microphysical, optical, and radiative properties of predefined aerosol types, to derive the input parameters for radiative transfer calculations



Serves as a common baseline for the **development**, **evaluation** and **implementation** of EarthCARE algorithms

Synergy between:
- ATLID (Atmospheric Lidar)
- MSI (Multi-Spectral Imager)
- BBR (Broad-Band Radiometer)

Hybrid: **theoretical** microphysical description fits the **experimental** findings

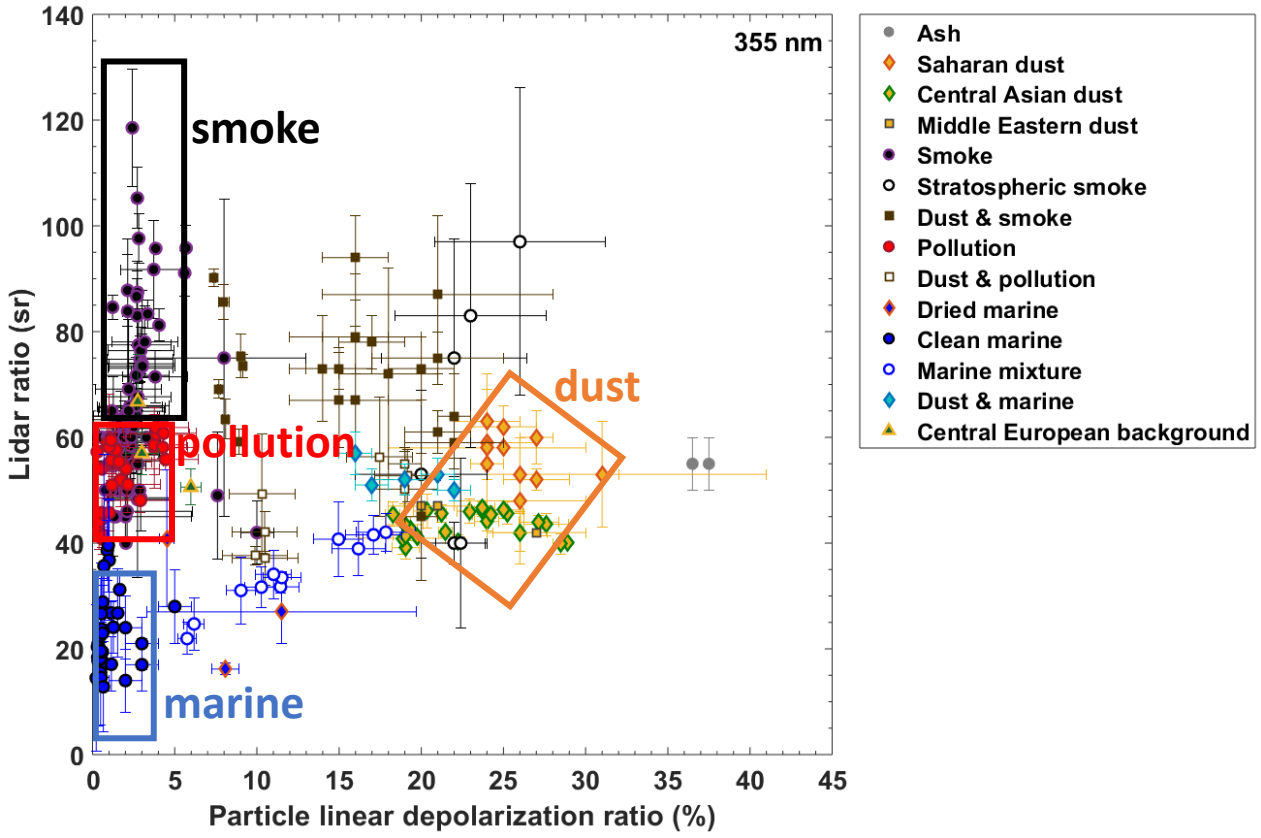
End-to-end: **uniform** representation of the different aerosol types in terms of **microphysical**, **optical** and **radiative** properties

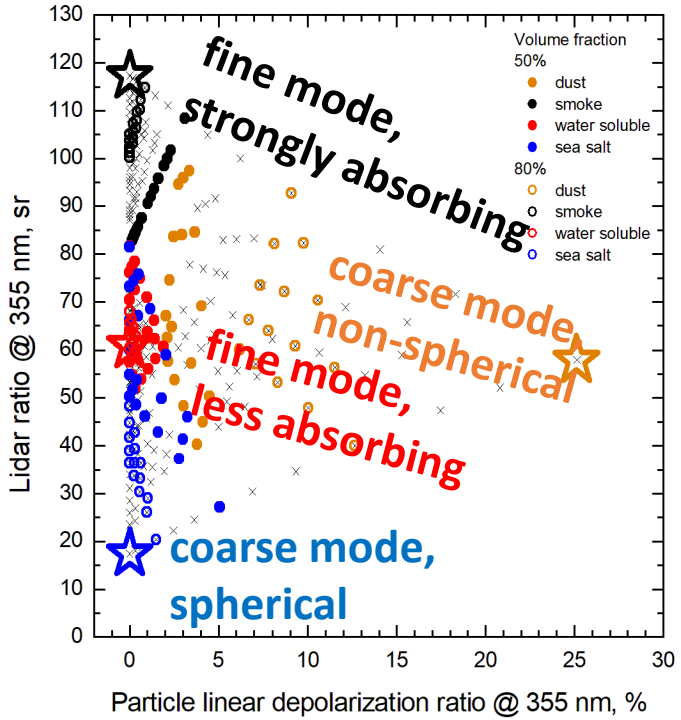
Wandinger et al., 2023
Illingworth et al., 2015

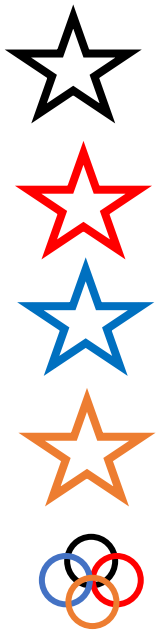
Aerosol types are composed of basic **aerosol components**

(ESA Climate Change Initiative (CCI)- AERONET probability distribution statistics)

DeLiAn as baseline







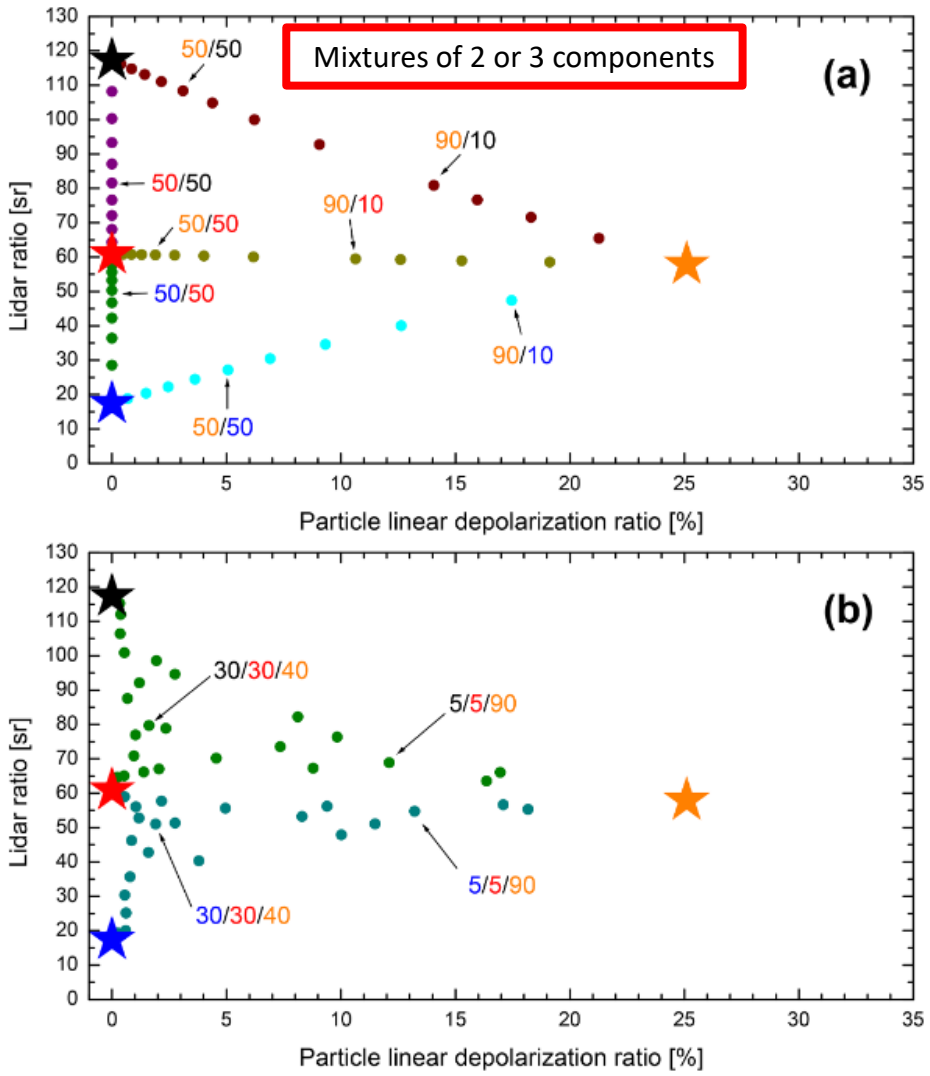
S = 117.2 sr
δ = 0

S = 60.9 sr
δ = 0

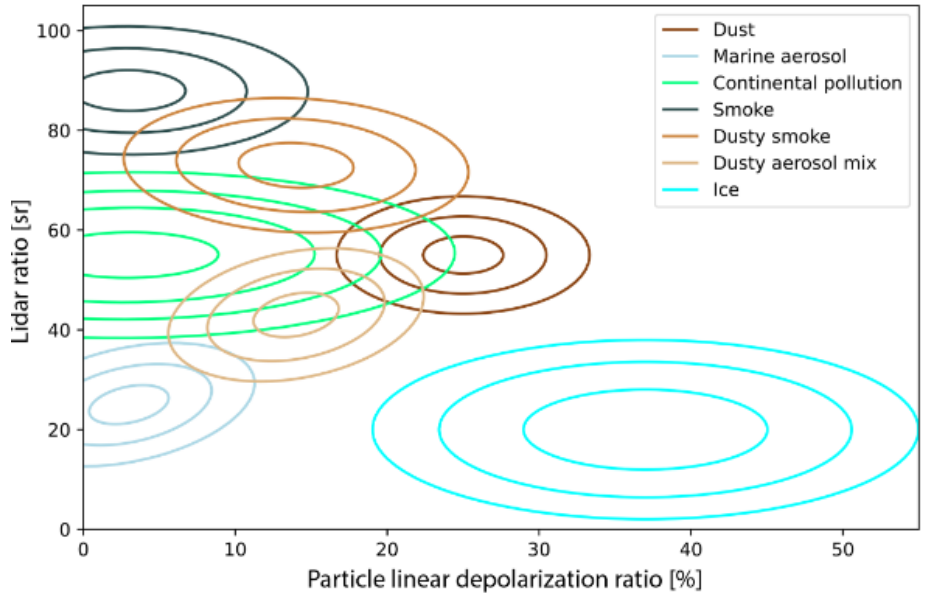
S = 17.4 sr
δ = 0

S = 57.9 sr
δ = 0.25

Mixtures - Lookup tables



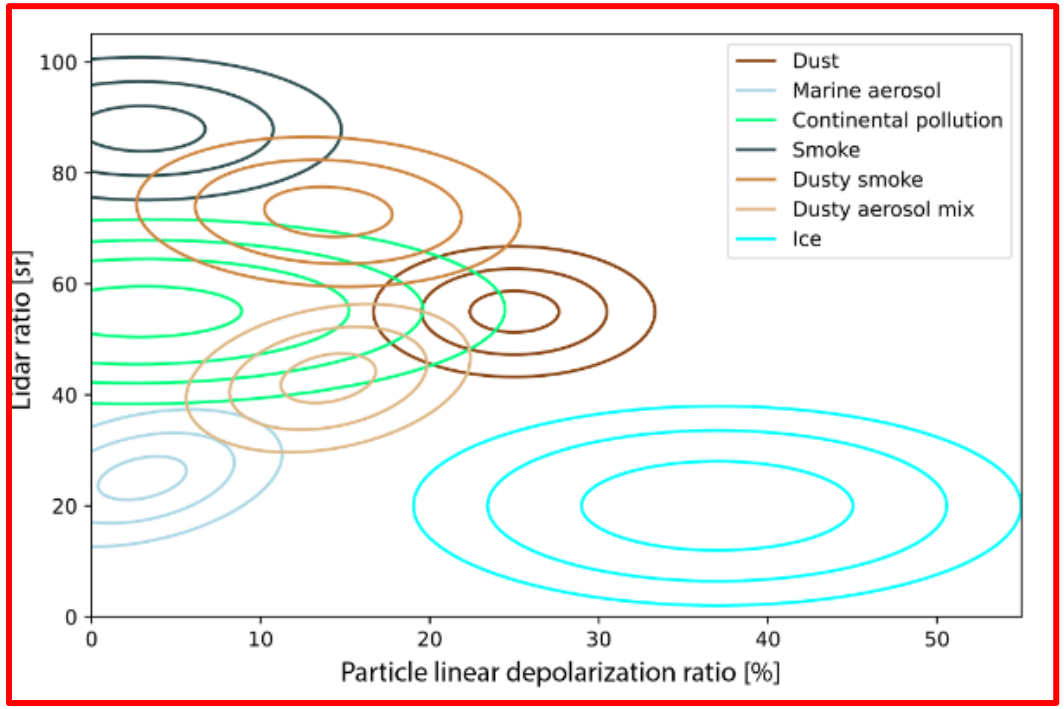
ATLID Target Classification

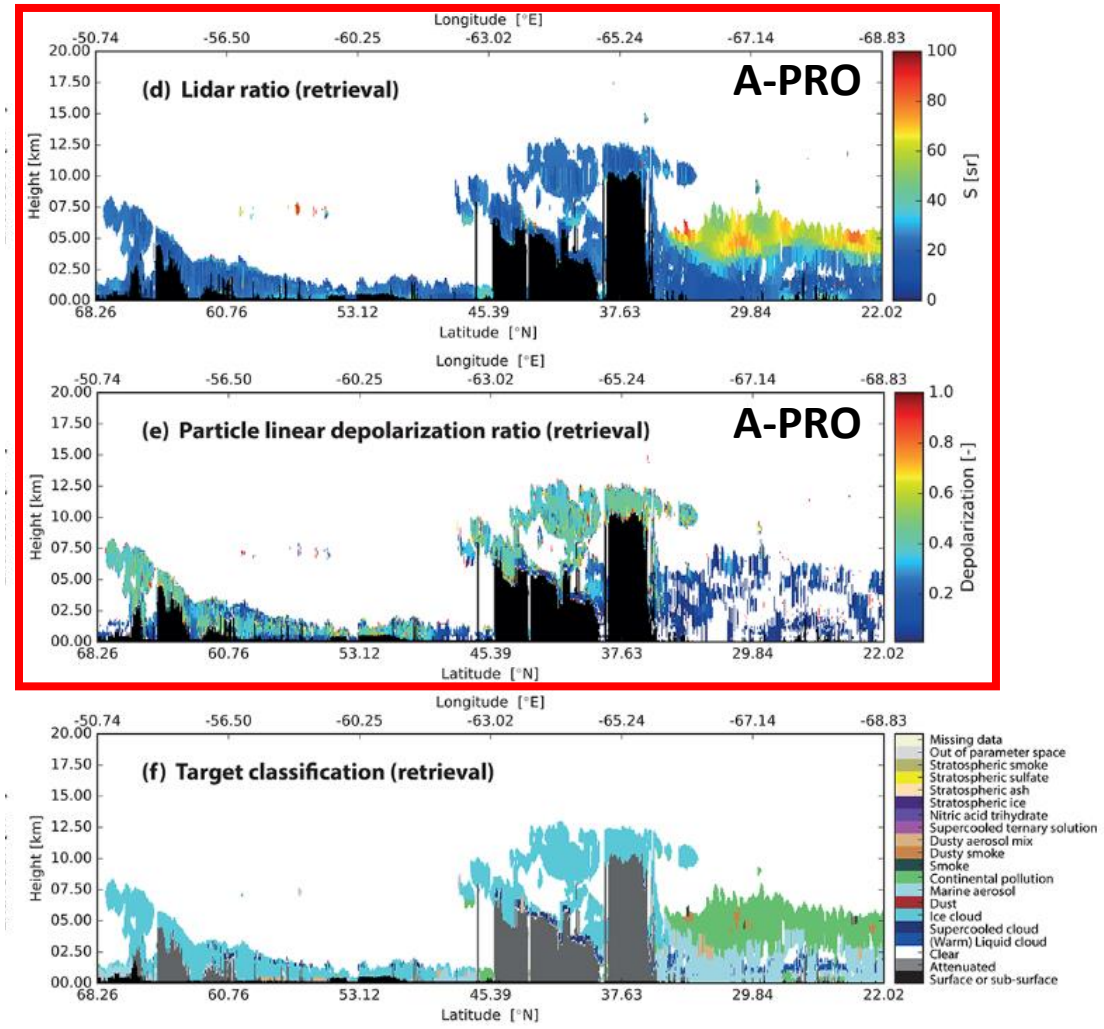


The joint S–δ distribution for each aerosol type is modeled using a Gaussian probability distribution defined by a mean lidar ratio, particle linear depolarization ratio, and their associated Gaussian widths and correlation.

Wandinger et al., 2023

HETEAC – Halifax scene

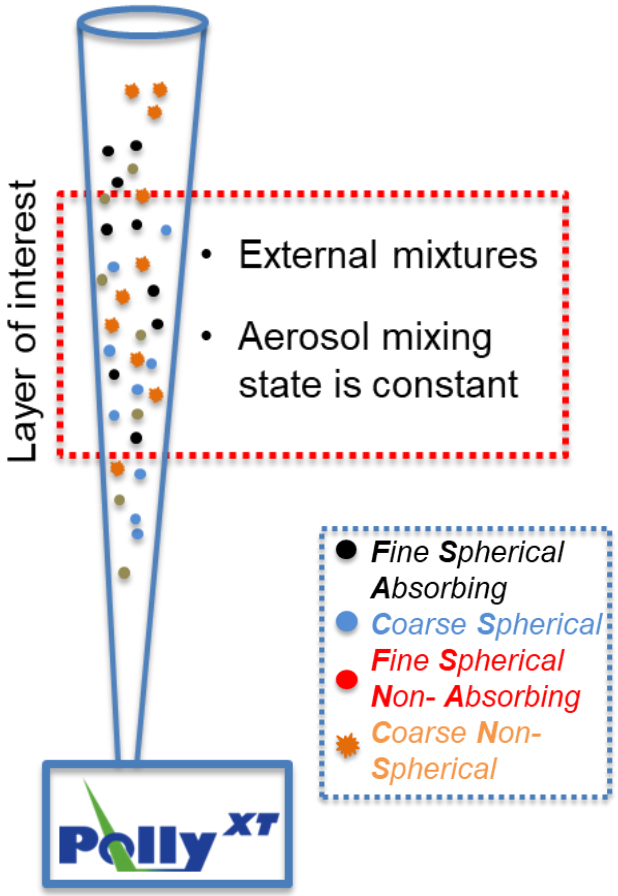




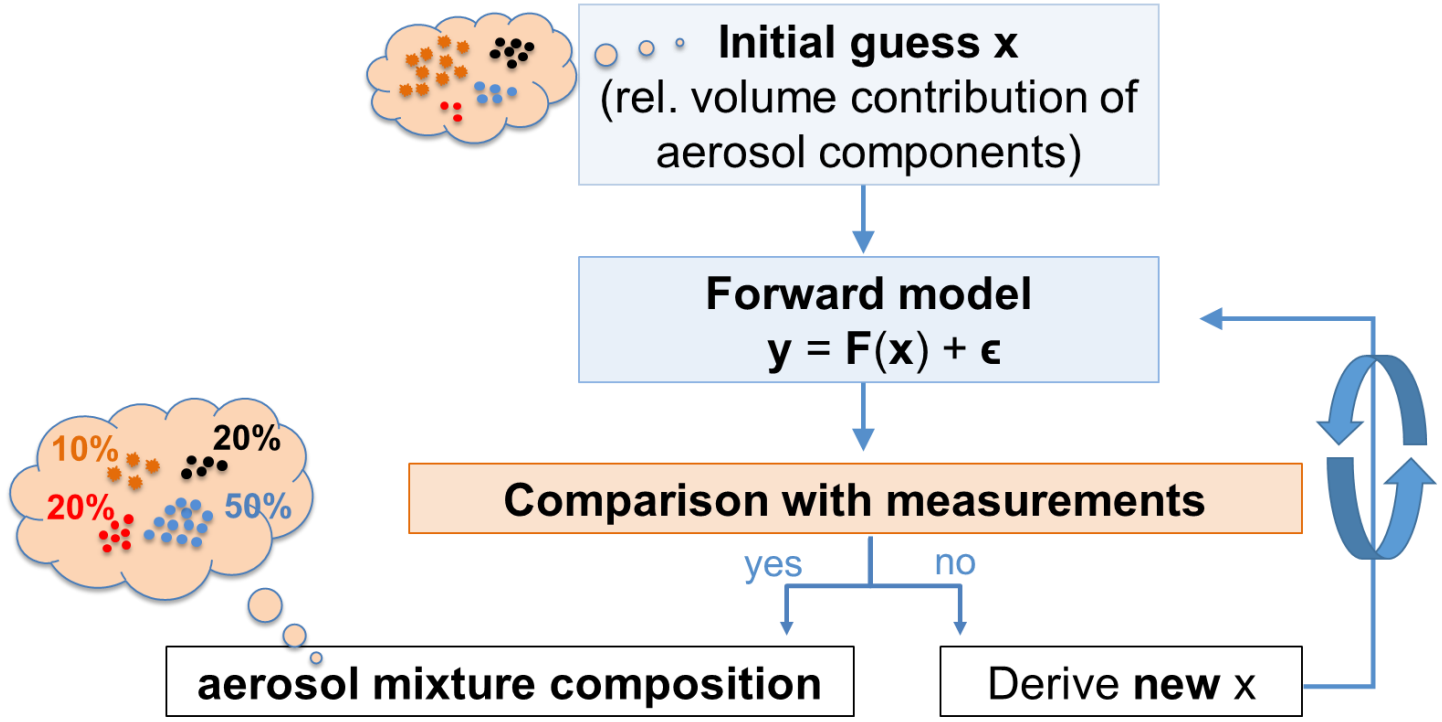
Wandinger et al., 2023

HETEAC- Flex

- Based on lidar-derived intensive optical properties
- Microphysical properties in accordance with HETEAC

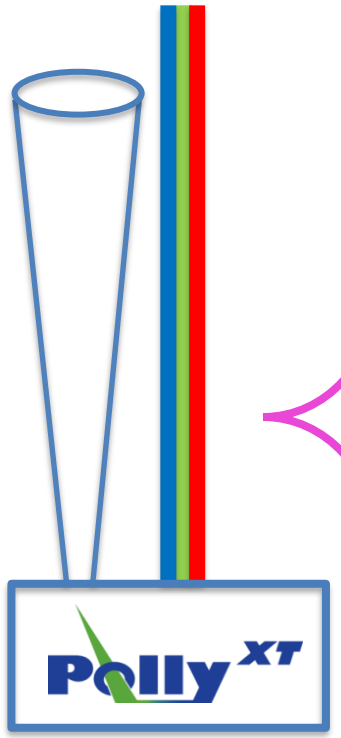


- Identification of up to four different aerosol components / quantification of their contribution to the aerosol mixture in terms of relative volume
- Applicable to ground-based and spaceborne lidars
- Flexible

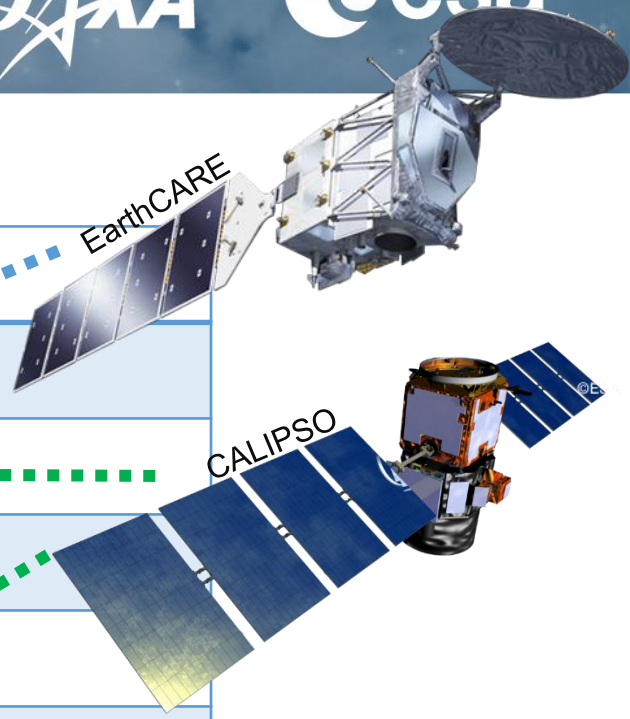


Floutsi et al., EGUsphere, in review

HETEAC- Flex: flexibility



Retrieval modes	Input parameters
1	δ_{355}, S_{355}
2	δ_{532}, S_{532}
3	δ_{355}, S_{355}, $Å_{355/532}$
4	δ_{532}, S_{532},$C_{\beta 532/1064}$
5	δ_{355}, S_{355}, δ_{532}, S_{532}
6	δ_{355}, S_{355}, $Å_{355/532}$, δ_{532}, S_{532},$C_{\beta 532/1064}$



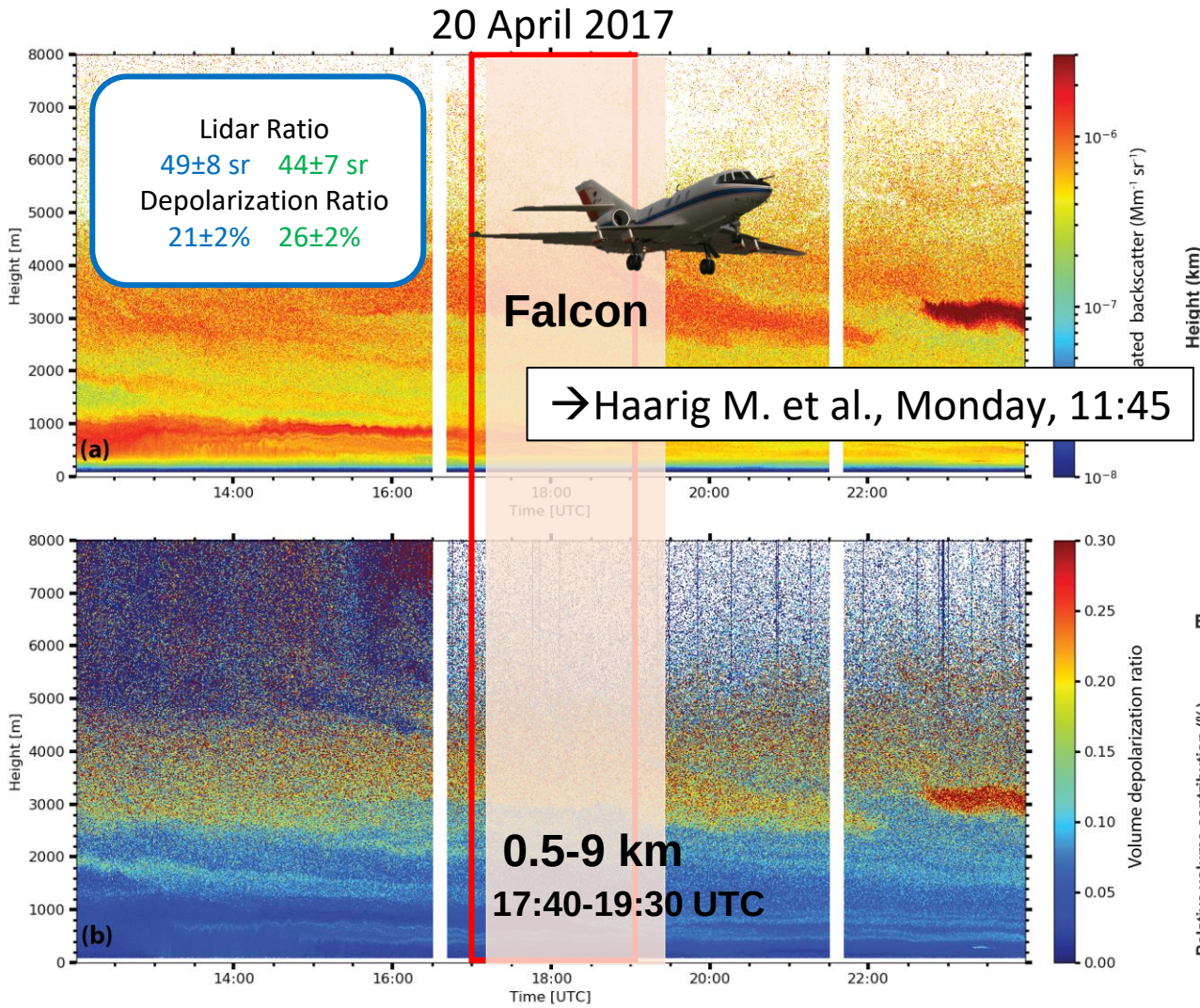
δ: depolarization ratio
S: lidar ratio
Å: Ångström exponent
C_β: color ratio

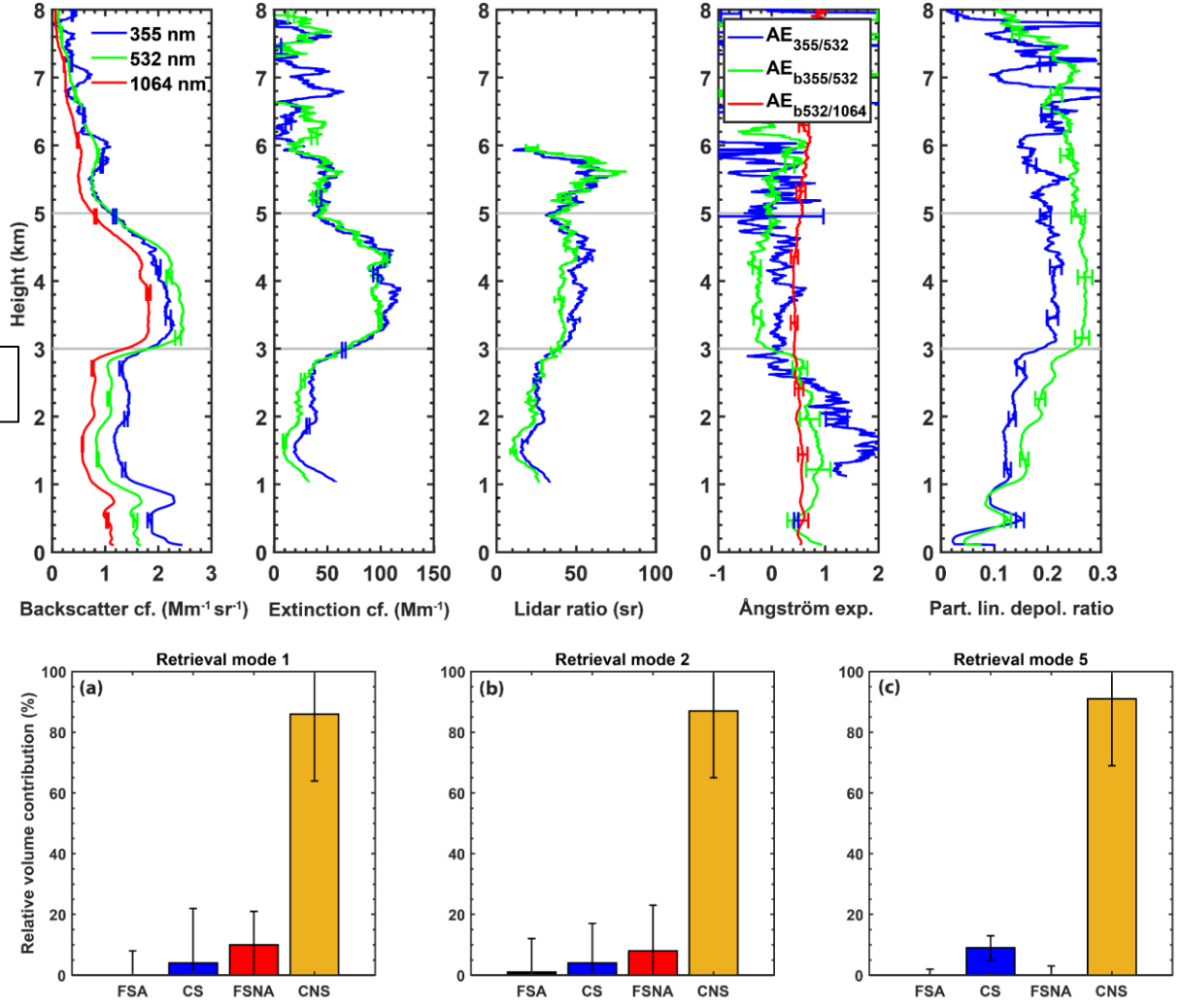
Widely applicable
Minimum requirement two parameters/measurement

EARLINET

Lidar configuration

Applications: Saharan dust above Cyprus





Floutsi et al., EGUsphere, in review

Summary & Outlook

HETEAC ensures uniform representation of aerosol types and consistency within the EarthCARE processors

- Tropospheric aerosol components are fully covered
- HETEAC 2.0 - take into account stratospheric aerosol types such as volcanic ash, sulfates, stratospheric smoke and polar stratospheric clouds (→ Poster no. 2)

HETEAC – Flex: high flexibility and easily applicable to ground-based lidars within cal/val framework

- Quantification of the aerosol mixing state
- Microphysical model to be continuously updated

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