ESA Climate Change Initiative
Aerosol_cci+ Phase 2

Technical Note (TN)
Aerosol component model update

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EXECUTIVE SUMMARY

This technical note briefly summarizes the main discussion points and results of three workshops held to assess the need and possibilities for an update of the Aerosol_cci aerosol component model.

Issue	Date	Modified Items / Reason for Change
Aerosol_cci+ Phase 2		
1.0	07.11.2025	Initial issue of the TN for an update of the component model
1.1	04.03.2026	Complete table with specifications of updated components in section 5 (SSA values) Shift dust absorption adjustments to longer community efforts (end of section 4)

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1 INTRODUCTION

Based on internal and external discussions, Aerosol_cci has developed and published a common aerosol component model in order to minimize the number of pre-selected aerosol types with up-to-date knowledge from a variety of sources (consistency and coverage by global modeling, quality references by AERONET statistics) together with common *a priori* assumptions for aerosol composition and size from model-derived or even better model-data merged climatological data. In light of the limited information content of passive radiometers for aerosol properties, a simple four aerosol component model has been selected, with two fine and two coarse mode components, with different characteristics as regards size, absorption and sphericity. These components can be mixed to simulate the most frequently occurring atmospheric aerosol types which subsequently can be used in the forward models to simulate the reflectance at the top of the atmosphere. An educated first guess for the mixing of the four components (in an underdetermined AOD retrieval environment) locally and seasonally characteristic fractions was provided in terms of monthly global 1x1 lat/lon data-sets: (1) the fine-mode AOD fraction, (2) the dust AOD fraction of the coarse mode and (3) the fraction of low absorbing fine-mode for a mixture of the low and high absorbing types. These fractions have been prepared based on model results from output of 14 different global models that participated in Aerocom exercises and AERONET data for AOD, Ångström exponent and single scattering albedo (SSA).

Evaluations of consecutive versions of Aerosol_cci algorithms, and especially those applied to dual view instruments (ATSR-2, AATSR, SLSTR) have shown remaining issues (inconsistency between (A)ATSR(-2) and SLSTR AOD CDRs, over-estiamtion of Fine Mode AOD fractions for all dual view instruments). In order, to overcome those issues, a re-assessment of the simple 4-component model was conducted with the goal to specify few small adjustments of this model which hold the potential to overcome the observed issues.

1.1 Scope

This document describes the outcome of the discussions for an update of the Aerosol_cci aerosol component model to be tested and evaluated in Aerosol_cci+ Phase 2.

1.1.1 Applicable Documents

[AD1] Request for CCN proposal ESA-EOP-SC-AMT-2021-47: “Aerosol_cci+ Phase 2”

[AD2] It’s Annex B: Aerosol

[AD3] The Prime Contractor’s Baseline proposal, ref. 3032766, v1.1 dated 16.04.2025

1.1.2 Reference Documents

[RD1] Holzer-Popp, T., de Leeuw, G., Martynenko, D., Klüser, L., Bevan, S., Davies, W., Ducos, F., Deuzé, J. L., Graigner, R. G., Heckel, A., von Hoyningen-Hüne, W., Kolmonen, P., Litvinov, P., North, P., Poulsen, C. A., Ramon, D., Siddans, R., Sogacheva, L., Tanre, D., Thomas, G. E., Vountas, M., Descloitres, J., Griesfeller, J., Kinne, S., Schulz, M., and Pinnock, S., Aerosol retrieval experiments in the ESA Aerosol_cci project, Atmos. Meas. Tech., 6, 1919 - 1957, doi:10.5194/amt-6-1919-2013, 2013

[RD2] de Leeuw, G., T. Holzer-Popp, S. Bevan, W. Davies, J. Descloitres, R.G. Grainger, J. Griesfeller, A. Heckel, S. Kinne, L. Klüser, P. Kolmonen, P. Litvinov, D. Martynenko, P.J.R. North, B. Ovigneur, N. Pascal, C. Poulsen, D. Ramon, M. Schulz, R.Siddans, L. Sogacheva, D. Tanré, G.E. Thomas, T.H. Virtanen, W. von Hoyningen Huene, M.Vountas, S. Pinnock, Evaluation of seven European aerosol optical depth retrieval algorithms for climate analysis, Remote Sensing of Environment, 162, 295-315, doi: 10.1016/j.rse.04.023, 2015; see Annex 3

[RD3] Wandinger, U., Floutsi, A. A., Baars, H., Haarig, M., Ansmann, A., Hünerbein, A., Docter, N., Donovan, D., van Zadelhoff, G.-J., Mason, S., and Cole, J.: HETEAC – the Hybrid End-To-End Aerosol Classification model for EarthCARE, Atmos. Meas. Tech., 16, 2485–2510, https://doi.org/10.5194/amt-16-2485-2023, 2023

[RD4] EUMETSAT planning in the PMaP and 3MI context (recent dedicated workshop – confidential note), 2025

[RD5] Kinne et al., An AeroCom initial assessment – optical properties in aerosol component modules of global models, *ACP, 6,* 1-22, 2006

[RD6] Dubovik, O., et al., Application of spheroid models to account for aerosol particle nonsphericity in remote sensing of desert dust, *J. Geophys. Res.*, 111, D11208, doi:10.1029/2005JD006619, 2006

[RD7] Aerosol_cci, Phase 1 Technical Note Aerosol_cci aerosol component model, ESA, 2011

[RD8] Aerosol_cci+2 typing_ workshop (15/09/2025), MoM, v1.0, ESA, 2025

[RD9] Aerosol_cci+2 aerosol component model decision meeting (22/10/2025), MoM, v1.1, ESA, 2025

2 INTRODUCTION

Aerosol_cci+ Phase 2 has the task to revisit the Aerosol_cci 4-component approach to define common aerosol properties (which can be externally mixed) for European satellite sensors of the last 2 decades (such as ATSR-2, AATSR, SLSTR, MERIS, OLCI, POLDER, …). In Aerosol_cci, these 4 components were defined after several rounds of internal and external discussions based on AERONET mean properties and could be used with AEROCOM median mixing fractions between those 4 components (after Kinne, et al., 2006). The 4-component model is described in Holzer-Popp, et al., 2013 and its use is analysed in de Leeuw et al., 2015. For the mineral dust component, we used the dust moel defined in Dubovik, et al., 2006.

The starting point for this discussion is two-fold:

- We need to keep the setup as simple as possible to reflect the limited information content of the envisaged sensors and to foster practical implementation (e.g. avoid iterative adjustments as far as possible)
- We seek some improvement to support mainly 2 goals for the dual view sensors:
    - Help improve the fine mode fraction retrievals
    - Help improve the consistency of the ATSR (oblique forward viewing) with the SLSTR (oblique rearward viewing) instruments

Additionally, we aim to keep best possible consistency or ways of translation to the EarthCare aerosol typing (Wandinger, et al., 2023). Furthermore, we liaise also with ongoing discussions under EUMETSAT aspices for EPS-SG and Sentinel-3 aerosol retrieval algorithms and first results of the PACE community, represented by SRON.

3 RECENT DEVELOPMENTS AND UNDERSTANDING

We collect here the material obtained during two workshops (internal Aerosol_cci+ Phase 2 on 08/09/2025) and with external experts (on 15/09/2025).

Motivation:

- Validation with AERONET shows:
  - AOD bias for SU higher for SLSTR than for AATRS – different viewing directions forward – reward
  - FM-AOD bias higher than AOD bias – improvements of the models needed
- Recap of 4-component concept (optically similar particles in one component)
  - Refractive Index (RI) + size distribution from literature -> Mie /T-Matrix calculations of optical properties
  - Fine mode: 2 extreme absorption values
  - Coarse mode: 2 main geophysical components: dust and sea salt
  - Size: from AERONET
  - AEROCOM median for climatological mixing fractions used in the retrievals when parameter can not be retrieved

aerosol component	Refr. index, real part (55μm)	Refr. Index, imag part (.55μm)	reff (μm)	geom. st dev (σ_i)	variance (ln σ_i)	mode. radius (μm)	comments	aerosol layer height
Dust	1.56	0.0018	1.94	1.822	0.6	0.788	non-spherical	2-4km
sea salt	1.4	0	1.94	1.822	0.6	0.788	AOD threshold constraint	0-1 km
fine mode weak-abs	1.4	0.003	0.140	1.7	0.53	0.07	(ss-albedo at 0.55 μm: 0.98)	0-2 km
fine mode strong-abs	1.5	0.040	0.140	1.7	0.53	0.07	(ss-albedo at 0.55 μm: 0.802)	0-2 km

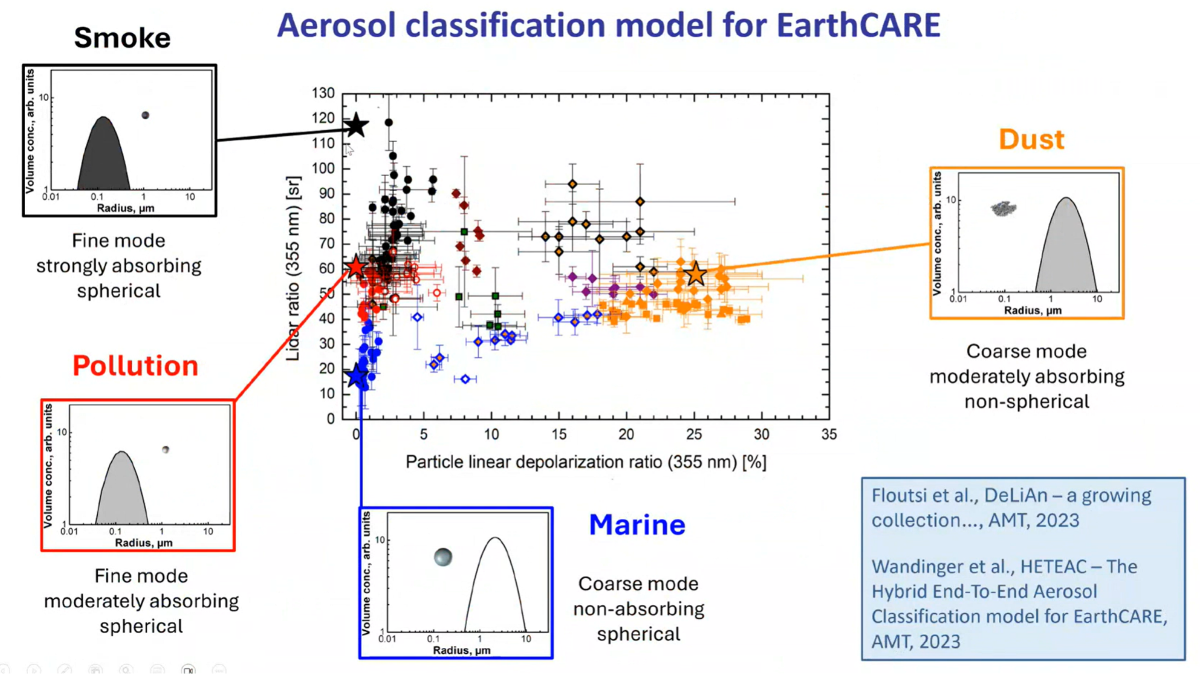
Goals / constraints of the re-assessment of the aerosol component model:

- keep it simple
- applicable for different sensors
- Aerosol_cci+
  - Improve ATSR – SLSTR consistency
  - Improve SLSTR FM-AOD
- Community goals:
  - Safeguard consistency /translatability with other sensors (from weaker to strongest instruments)

- Particularly with EUMETSAT/3MI, EarthCARE
- Constraints:
  - Change only what is most needed
  - Foster practical implementation
  - Remain realistic with regard to information content of the retrievals
- Future possibilities:
  - Use climatology of aerosol type, vertical profiles, RI, effective radius (R_{eff}) from 3MI, SPEXOne, EarthCARE
  - Consider hygroscopicity

Aerosol_cci+ initial discussions (Thomas Popp)):
- No update of fine mode components needed
- Two different dust components with different size
  - dependent on distance to source
  - or dependent on DAOD – iterative (-> Stefan)
- Probably no need for different size bins for sea salt

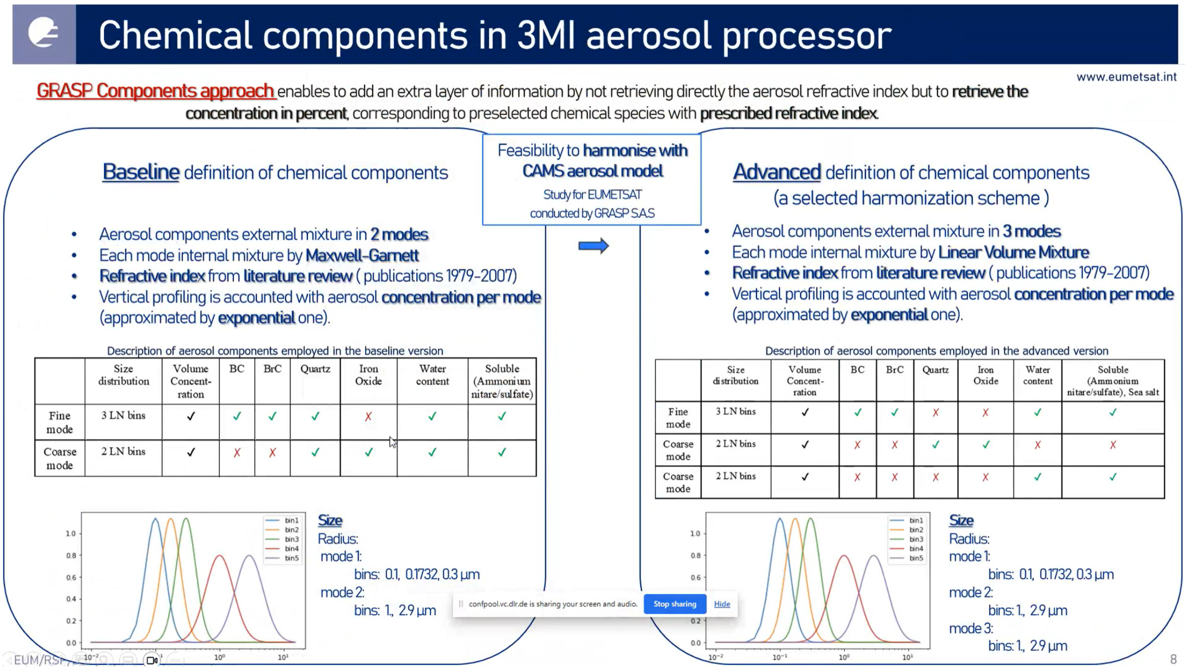
Aerosol classification for EarthCARE (Ulla Wandinger)



- Lidar ratio and particle linear depolarization ratio used for aerosol classification
- Spheroidal shape distribution: like OPAC 4.0 database; dust potato-like, works better for depolarisation ratio and the lidar ratio (on a single wavelength)
- The Aerosol_cci components work only in troposphere, but smoke events and volcanos reach stratosphere
- Changing properties of smoke

- Vertical distribution consideration
- Component mixtures: trimodal mixtures could cover the observation space better than bimodal mixtures
- Smoke is not fine mode but accumulation mode
- Absorption needs improvements
- Spectral complex refractive index:
  - Real part: seams ok
  - Imaginary part: improvements needed
- Suggestions:
  - Decrease absorbing of weak absorbing fine mode
  - For dust: spheroidal shape (potato like)

<u>Aerosol Characterisation in operational context of EPS-SG /3MI (Soheila Jafariserajehlou)</u>



- Fraction of chemical components
  - Sea salt brings improvements
  - Internal or external mixing?
  - Refractive index
  - 5 chemical components: Black carbon (BC), Brown Carbon (BrC), dust (Quartz, Iron Oxid), Water/Sulphate, Water/Sea Salt
- Size distribution:
  - Min. 1 fine (with sub-components) + 2 coarse (dust + sea salt)
  - Dust consideration (super-coarse, 2 dust modes) – to be tested
- Need for refractive index (RI) update/evaluation
- Hydroscopic growth – relative humidity
- Consider non-sphericity for coarse dust
- Vertical profile:

    - Parameterised: preferably consistent
    - boundary layer, CAMS profile forecast (per component), climatology, assumptions
    - Retrieval of AHL: focus on average height

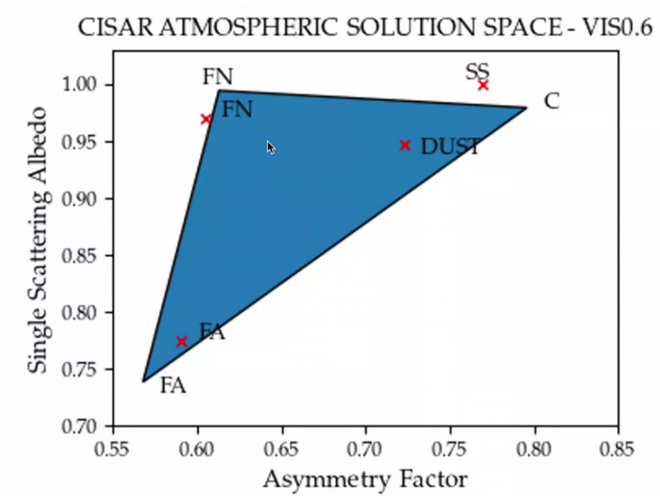
<u>Reflections from modelling perspective (Stefan Kinne)</u>

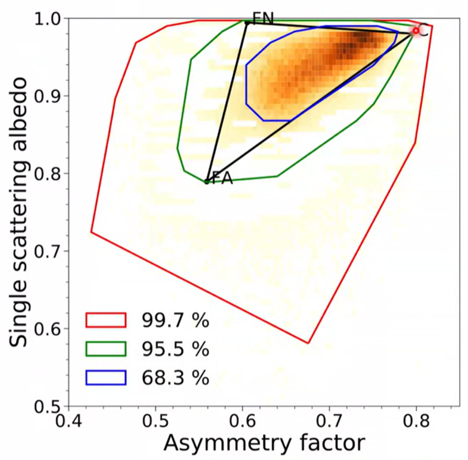
- 4 component model improvement
- Dust needs to be larger near the source, size change influence to AOD
- Fifth component: add coarse dust
- Associations: AOD – FM-AOD (climatology),
- CM-AOD – SSAOD (from wind, latitude / longitude, land fraction) = DAOD, much dust -> more coarse dust -> smaller SSA
- 1 micro meter as threshold to distinguish fine and coarse modes

<u>Views from Swansea retrieval (Peter North)</u>

- More bias in SLSTR than in AATSR
- Uses the 4 components
- Tested: 7-40 discrete models but continuous better
- CM- and FM-AOD in right regions
- Overestimate FM-AOD (in dust regions)
- Recommended research:
    - Scope to improve existing FMF
    - Currently single dust model (location dependent internal mixture of dust, implementation on LUT)
    - More than the 2 parameters not possible with SLSTR

<u>Views from CISAR algorithm (Yves Govaerts)</u>





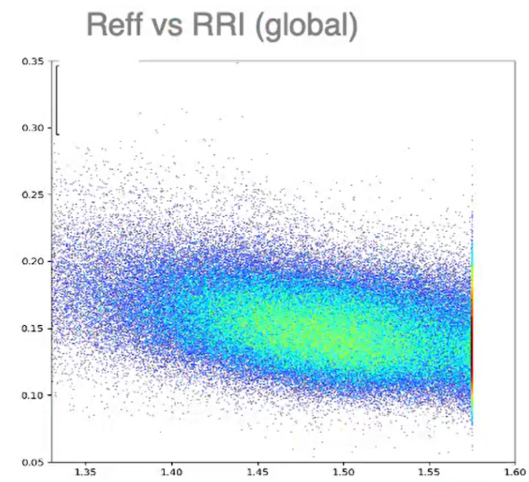
Luffarelli, M. and Govaerts, Y. (2019)

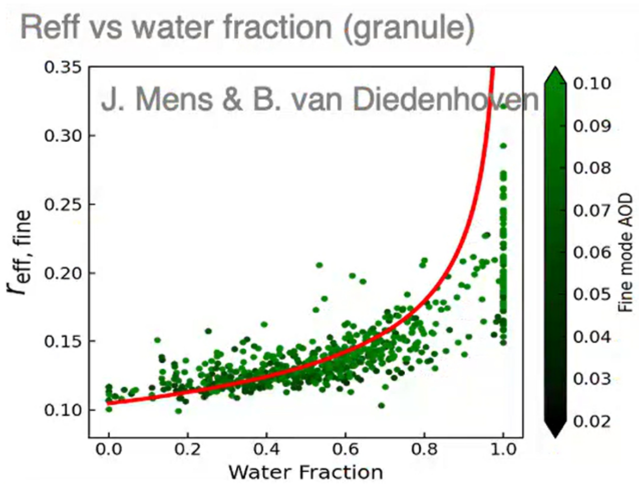
- Micro-physical properties not directly appearing in RTE -> Mie Theory -> Single Scattering Albedo and phase function -> RTE
- CISAR solution space: asymmetry factor – single scattering albedo
- Recommendation: Single Scattering Albedo and phase function more relevant than microphysical parameters
  - Components need to span this parameter space well and be clearly distinguishable from each other (and from clouds)
  - FA, FN, C (corners of the blue triangle): CISAR 3 state parameters for aerosol components
  - FN, FA, DUST, SS (x): Aerosol_cci model 4 components

Recommendations based on PACE/SPEXone retrieval (Otto Hasekamp)

	Reff	Veff	RRI	IRI	N	Sph	ALH
Fine mode	✓	✓	✓	✓	✓	✓	✓
Coarse insoluble mode (dust)	✓	✓	x	✓	✓	x	✓
Coarse soluble mode	✓	✓	✓	x	✓	x	✓
Surface	Land: BRDF Ross-Li, snow parameters, Maignan BPDF. ocean: Chlorophyll-a, wind-speed, + Lambertian correction term						
Optical Properties	AOT, SSA, phase function, Angstrom Exponent						

IRI is constructed from aerosol components Brown Carbon (BrC), Black Carbon (BC), and Dust.





- Multiangle polarimeter: high information content
- Fine mode, coarse insoluble mode (dust), coarse soluble mode (Sea salt)
- Discussion to add fine soluble mode
- Fine mode effective radius – RRI: hydroscopic grows
- 4 components:
  - Fine non-absorbing: FMF>0.5, SSA>0.95
  - Fine absorbing: FMF>0.5, SSA<0.95

        - Coarse insoluble dominated: volume fraction of dust >0.5
        - Coarse soluble dominated: volume fraction of (hydrated) sea salt>0.5
    - Recommendation:
        - 3 mode aerosol description: fine, coarse non-spherical (insoluble), coarse spherical (soluble) maybe plus fine non spherical (insoluble)
        - Make use of knowledge on water uptake R_{eff} and Real RI dependent on relative humidity
        - Use surface BRDF from climatology (PACE/3MI)
        - Probably 3 pieces of information available on size, fit contribution of 3 modes, choose between absorbing/non-absorbing fine mode based on external information (climatology from PACE/3MI, CAMS, MERRA2)
        - If 2 pieces of information available, choose between dust and sea salt based on external information
        - Make use of microphysical properties retrieved from SPEXone and 3MI

Collected ideas, comments, thoughts:

- Need to quantify influence on the retrievals: Sensitivity study (Bastiaan)
- Future goal to retrieve aerosol components -> validation of components needed (Soheila)
- Try to harmonize / link components to CAMS model (Soheila)
- Different dust in different regions (Sahara – Asia different absorption even within Asia: Taklamakan, Gobi) (Gerrit, Ulla) – cloud be included in climatological component mixtures (Stefan)
- 10 µm is an extreme; looking for 2 extremes (long transported small – or near source); maybe different dust models of different locations (Asia, Sahara…); sea salt dried (Stefan)
- Dried lakes as source of dried “sea” salt, nonspherical, e.g. lake Aral (Ulla)
- super coarse dust: GRASP and SRON RemoTAP tried it in the retrieval, but this made the retrievals worse (Otto; confirmed by Yves) -> Thomas: make the large dust component not too coarse
- Issues with in-situ measurements: dried particles – could be a reason for wrong R_{eff} and Real RI; Modelling world uses a lot of in-situ and lab data (Bastiaan)
- Mind: the differences between effective radius – mode radius and volume distributions vs. number distributions (Otto, Ulla)
- Smoke is not fine mode but accumulation mode and has increasing relevance (more frequent and stronger fire events; big smoke events / Pyrocumulunimbus reach into the stratosphere -> vertical profiles matter (Ulla)
- Promising consistency of R_{eff} between statistics shown: Aerosol_cci / Aeronet – SPEXOne statistics, EarthCARE statistics; larger discrepancies for RI which may be tied to water update (Thomas)
- Agreement, that dust shows largest variability (Thomas)

- Dual view instruments (no UV / blue channels; no explicit 180° backscatter) are less sensitive to larger dust spectral absorption / depolarisation (Thomas)
- In analysing aerosol components and their differences in the SSA-ASYM space, we should not only consider the bulk of the distribution of individual cases, but also less frequent extreme events (dust outbreaks) – this could justify to extend fronm a triangle to a quadrangle
- Active communities to work on pre-defined aerosol components
    - ESA Aerosol_cci
    - ESA / JAXA EarthCARE, AIRSENSE
    - EUMETSAT 3MI & NRT S3 optical Synergy, recent workshop
    - PACE / RemoTAP
- Need to analyse all current and considered future components in the SSA_ASYM space (as CISAR) -> Yves agreed to do those calculations; Stefan has already provided input
- Future potential to use statistics from 3MI, SPEXOne, EarthCARE
- CCI next phase (2027 ff) work on aerosol will consolidate active and passive instruments, historic climate records should be tied to modern instruments (Michael)

4 OUTCOME OF AEROSOL_CCI DECISION MEETING

On 22/10/2025, the Aerosol_cci+ Phase 2 team discussed the insights obtained at the two workshops and conducted additional analysis which led to the following conclusions.

<u>Analysis of components in SSA – ASY space with underlying Aeronet statistics</u>
(courtesy of Rayference)

Data used:

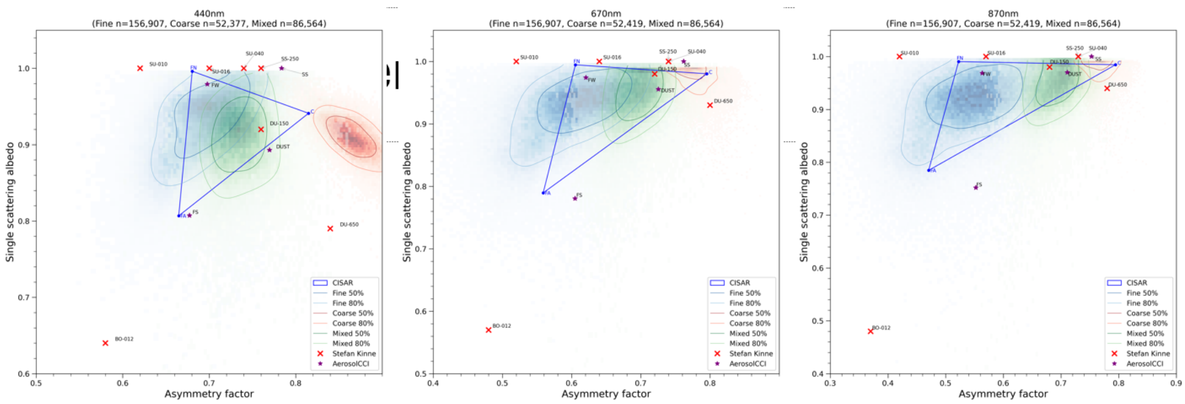
- **AERONET:** Aerosol Inversions (V3) Almucantar scenario, Level 2.0, all data used after filtering with AOD ≧ 0.3 for blue band & SZA > 50 for all λ
  - Separated by fine-mode and coarse-mode: ASY available in the files, SSA calculated by Angstrom exponent and Fine Mode Fraction splitting: *Coarse ANG < 0.7 FMF < 0.4* | *Fine ANG > 1.2 FMF > 0.6*
- **CISAR:** SSA derived from scattering coefficient (sca) and extinction coefficient (ext), and ASY
- **Stefan Kinne:** Absorbing fraction (1 – SSA) and ASY

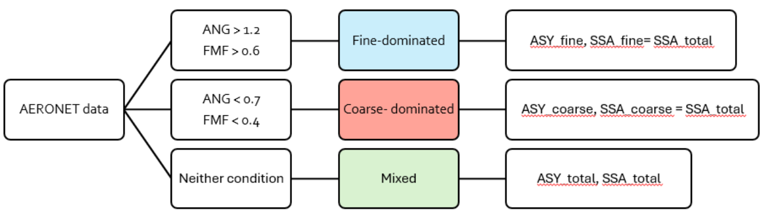
Fine-mode		Coarse-mode	
Absorbing	Non-absorbing	Absorbing	Non-absorbing
BO-012	**SU-010, SU-016, SU-040**	**DU-150, DU-650**	**SS-250**
Organic Carbon (OC) + Black Carbon (BC) core 120 nm reff	Sulphate, 100 nm reff - lower size bound, 400 nm reff – upper size bound, 160 nm reff – average size (if no fine-mode size discrimination is possible)	Dust, 1500 nm reff – lower size bound, 6500 nm reff – upper size bound	Sea Salt, 2500 nm reff, presenting scattering coarse-mode

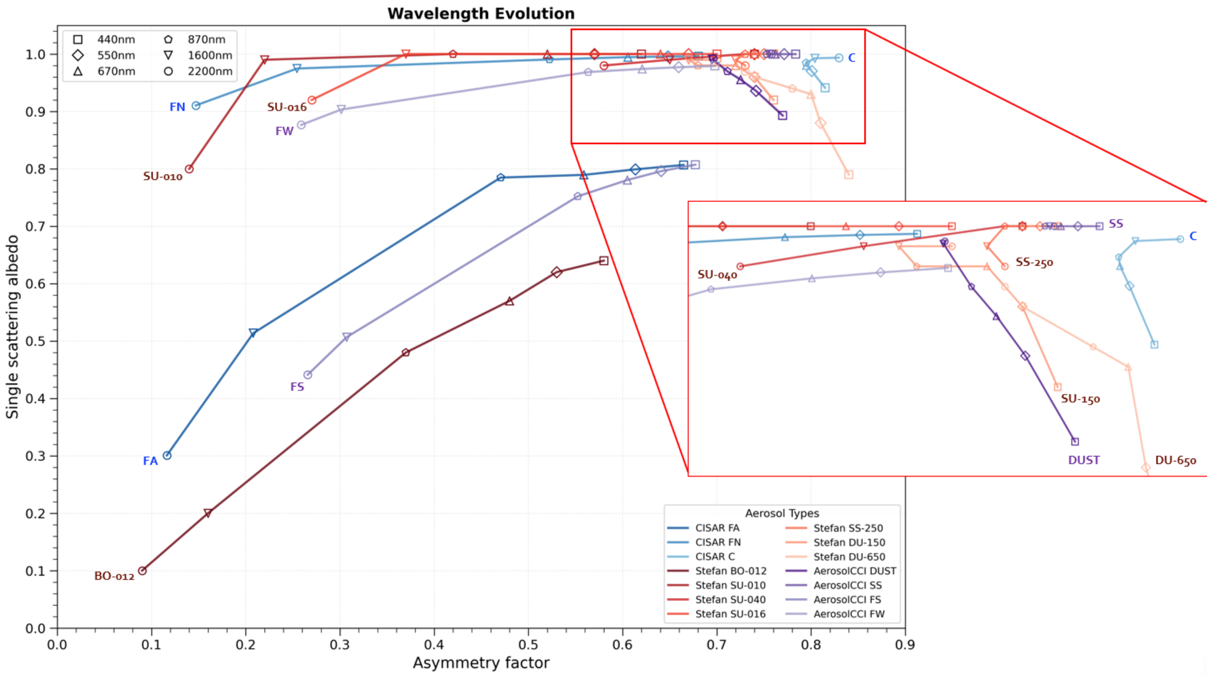
- **Aerosol_cci:** OPAC files for each type, SSA derived from extinction and absorption, and ASY derived using the ratio method by integrating all the forward and backward directions

Fine-mode		Coarse-mode	
Weak-absorbing	Strong-absorbing	Absorbing	Non-absorbing
FW	**FS**	**DUST**	**SS**

Single scattering albedo (SSA) & Asymmetry factor (ASY)







<u>Discussion about implementing the different possible changes to the components:</u>
SU: two different "experiments" to test the effect on the retrieval in current phase:

- 2 dust components (1µm and 5µm effective radius and different absorption (dust nearer to source -> larger -> more absorbing)
- Separate test: Shift the fine mode components to smaller sizes

➔ Both possible if T-Matrix and Mie calculations provided (and for the 2 dust components the mixture of both)

CISAR: Finetuning 3-component model (Fine weak / strong absorbing, Coarse)

- Possible change of size of fine mode components (FM ASY to large)
- Coarse mode maybe a bit larger
- Long term (Aerosol_cci+ Phase 2 option): 2 separate triangles in solution space (one for fine mode and one for coarse mode)
- Changing to the CCI Components would need a lot of algorithm development

Further comments:

- Change Fine mode weak absorbing to SSA=1 in later versions
- Keep consistency with EarthCARE and other community developments in mind
- Dust (CCI) and Coarse Mode (CISAR): T-Matrix calculations; FM and Sea salt (CCI): Mie calculations
- Aerosol_cci+ Phase 2 option will focus on changing the algorithms not processing a big amount of data

Decision by the Aerosol_cci+ Phase 2 team in its meeting on 22/10/2025:
To be taken up by: Aerosol_cci+ Phase 2 core project, Aerosol_cci+ Phase 2 option, longer-term community iterations (EarthCARE, EUMETSAT / 3MI+SLSTR)

- We need to go forward in three timelines
  - short term (for Aerosol_cci+ Phase 2 core project, until 12/2026)
  - Aerosol_cci+ Phase 2 option with additional budget, until 12/2026)
  - longer term (harmonized between the different retrieval communities)

- Possible approaches to adjust the Aerosol_cci 4-component model
  - replace the current dust component (Dubovik 2006; R_{eff} = 1.94 µm) by two non-spherical components spanning the observed variation without too extreme cases: R_{eff} = 1 µm and R_{eff} = 5 µm; also adjust dust absorption to increase with increasing effective radius (but not as strong as by Kinne)
  - Test with small data amount for Swansea algorithm: decrease effective radius of the weakly absorbing component
  - define separate dust absorption in the dust belt: Sahara and westwards / Asia (less absorbing)
  - replace the Fine Mode weakly absorbing component by an entirely non-absorbing component
  - adjust sea salt size
  - to keep or even improve consistency with EarthCARE: update Real RI values to more recent lab or in-situ measurements; consider spectral dependency of Imaginary RI
  - iterate with EUMETSA ongoing model updates for EPS-SG and Sentinel-3

- Possible retrieval adjustments to use the updated Aerosol_cci component model
  - Mie / T-matrix calculations of optical properties (Oleg Dubovik: in-kind; Backup: Rayference, within resources)
  - Climatological mixing fractions of the 2 dust components: will be derived from MERRA-2 reanalysis (5 dust bins) by DLR
  - Iterative adjustment of dust size (mixing between the 2 dust components) as function of Dust AOD
  - Prescription of sea salt AOD as function of reanalysis wind-speed
  - Climatological regional more detailed footprint (West / East part of global dust belt) of Sahara and Asian dust
  - Interact also with BSC (expertise on dust mineralogy and absorption measurements by region)

On this basis, the following final section contains the specifications for a (limited) aerosol component update which will be tested and evaluated in the Aerosol_cci+ Phase 2 core project (highlighted in red in the decisions list above).

Oleg Dubovik / LOA has kindly agreed to conduct the new T-matrix / Mie calculations for those updated components, providing similar files as for Aerosol_cci in 2013. DLR will prepare a “mixing fraction climatology” between the 2 dust components from MERRA-2 reanalysis.

5 SPECIFICATION OF AEROSOL_CCI MODEL UPDATE

We condense here the key specifications of the updated aerosol component model and compare them to the original Aerosol_cci component model.

Aerosol components – size distributions and properties

We use a log-normal size distribution:

$$\frac{dN(r)}{dlnr} = \sum_{i=1}^{2} \frac{N_i}{\sqrt{2\pi}\, ln\, \sigma_i} exp\left[-\frac{\left(ln\, r_i - \ln \bar{r}_{gi}\right)^2}{2\, ln^2\, \sigma_i}\right]$$

with the following specifications.

Original Aerosol_cci components

aerosol component	refractive index, real part	refractive index, imagin. part	effective radius	geom. st. dev.	variance	mode radius	shape	single scattering albedo (SSA)	aerosol layer height
symbol	n	k	$R_{eff,\,i}$	σ_i	ln σ_i	r_{gi}		ω_0	
unit			[µm]			[µm]			[km]
wavelengths	@ all λ	@ all λ						@ 0.55 µm	
Dust	1.56	see below	1.94	1.822	0.6	0.788	Spheroids Dubovik, 2006	see below	2-4
Sea salt	1.4	0	1.94	1.922	0.6	0.788	spherical	1.0	0-1
Fine mode weak-abs	1.4	0.003	0.14	1.7	0.53	0.07	spherical	0.98	0-2
Fine mode strong-abs	1.5	0.040	0.14	1.7	0.53	0.07	spherical	0.802	0-2

Dust spectrally dependant properties					
wavelength	**refractive index, imagin. part**	**single scattering albedo (SSA)**	**asymmetry parameter**	**backscatter lidar ratio**	**linear depolarization ratio**
[µm]					
0.34	0.0055	0.7941	0.825	79.79	22.12
0.38	0.0045	0.8305	0.8041	63.16	23.36
0.44	0.0029	0.88719	0.773	46.58	24.82
0.47	0.0025	0.90409	0.7626	42.55	25.19
0.55	0.0018	0.93556	0.7415	35.88	25.79
0.67	0.0013	0.95912	0.722	31.6	26.31
0.865	0.001	0.97499	0.7058	29.92	27.17
1.02	0.001	0.97885	0.7002	30.22	27.72
1.6	0.0007	0.99069	0.6949	34.83	29.31
2.15	0.0007	0.9931	0.6966	41.4	29.44

Analysis of SSA-ASY plots for AERONET point clouds split into fine / coarse / mixed mode

The analysis of those plots at different wavelengths leads to the following specification of the updated component model. This is now a 5-component model, by replacing the one-size dust model with 2 dust models to represent the limits of the range of dust properties. Following changes are suggested, with their underlying motivation / justification:

- Split into 2 dust components
    - to bound the realistic coarse range
    - R_{eff}:
        - from 1.94 µm to 1.0 µm and 5.0 µm
    - adjusted refr. index imagin. part to co-vary with R_{eff} of the 2 dust components
        - @0.44 µm: from 0.0029 to 0.0025 and 0.0035
        - @0.55 µm: from 0.0018 to 0.0015 and 0.0022
        - @0.67 µm: from 0.0013 to 0.0010 and 0.0015
        - no change for larger wavelengths
- fine mode components adjustments (for additional retrieval tests)
    - reduce refr. index imagin. part of the weakly absorbing fine mode component
        - to better emcompass the AERONET fine mode point cloud
        - and to be fully consistent with EarthCARE
        - from 0.003 to 0.001
    - reduce fine mode R_{eff} to better encompass the AERONET fine mode point cloud
        - from 0.14 µm to 0.12 µm
    - no change at this point for sea salt due to overall low sea salt AOD

This leads to following update Aerosol_cci component table.

Updated Aerosol_cci components

aerosol component	refractive index, real part	refractive index, imagin. part	effective radius	geom. st. dev.	variance	mode radius	shape	single scattering albedo (SSA)	aerosol layer height
symbol	n	k	$R_{eff,\,i}$	σ_i	ln σ_i	r_{gi}		ω_0	
unit			[µm]			[µm]			[km]
wavelengths	@ all λ	@ all λ						@ 0.55 µm	
Dust, lower edge	1.56	see below	***1.0***	1.5	0.41	0.663	Spheroids Dubovik, 2006	0.968	2-4
Dust, upper edge	1.56	see below	***5.0***	1.9	0.64	1.785		0.849	2-4
Sea salt	1.4	0	1.94	1.922	0.6	0.788	spherical	1.0	0-1
Fine mode weak-abs	1.4	***0.001***	***0.12***	1.7	0.53	0.06	spherical	0.995	0-2
Fine mode strong-abs	1.5	0.040	***0.12***	1.7	0.53	0.06	spherical	0.793	0-2

Dust spectrally dependant properties		
	Dust, lower edge	**Dust, upper edge**
wavelength	**refractive index, imagin. part**	**refractive index, imagin. part**
[µm]		
0.34	***0.0045***	***0.0065***
0.38	***0.0035***	***0.0055***
0.44	***0.0025***	***0.0035***
0.47	***0.002***	***0.003***
0.55	***0.0015***	***0.0022***
0.67	***0.001***	***0.0015***
0.865	0.001	0.001
1.02	0.001	0.001
1.6	0.0007	0.0007
2.15	0.0007	0.0007