



Aerosol_cci+ Phase 2

Product Validation Plan

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**ESA Climate Change Initiative
Extension**

Aerosol_cci+ Phase 2

PRODUCT VALIDATION PLAN

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EXECUTIVE SUMMARY

This document outlines validation activities for the Aerosol_cci+ Phase project. The overarching goal is the evaluation of newly developed or modified satellite aerosol remote sensing products by independent partners of Aerosol_cci+ Phase 2.

The activities are two-fold: One major activity is the acquisition of high-quality reference data: (1) from ground-based sun-/sky-photometry and (2) available aerosol data products from satellite remote sensing. The other core activity is the visualization and the quantification of the skill of different versions of the Aerosol_cci+ Phase 2 remote sensing algorithms using standard validation methods (scatter plots of aerosol parameters and histograms of their differences to the reference with statistical metrics such as bias, standard deviation, correlation, difference maps to other satellite datasets). Validation includes also the statistical evaluation of pixel-level uncertainties provided in the products in comparison to the best estimates of the true error (namely the difference to the ground-based reference). To assure independence none of the evaluation partners is involved in retrieval development of the products concerned.

All evaluation efforts are intended to guide future directions within the project (determine needs for improvement and help identify causes of errors and / or their regional and seasonal behaviour) and also to provide a tool to monitor performance progress over time with efforts to improve the retrieval capabilities.

Each revision of the document contains minor updates (definition of validation metrics, planned test data years, schedule of validation documents) based on the initial implementations of the validation tasks in Phase 1 and the evolution of the work planning as decided in the annual meetings.

This validation plan starts with definitions and a brief description of validation activities (sec. 1, 2). Subsequently, the master schedule, resources summary, rules of unbiased validation, validation criteria and review process are summarized (sec. 3 – 7). Reference data and validation documents are described in sec. 8 and 9, respectively. Finally, section 10 discusses endorsement of the validation results.

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Issue	Date	Modified Items / Reason for Change
Aerosol_cci+ Phase 1		
1.0	06.08.2019	First issue of the document
1.1	29.08.2019	Addition of detailed description of FMI activities Addition of more detailed uncertainty analysis
1.2	08.10.2019	Revision based on RIDs raised by the ESA TO
2.0	28.07.2020	Minor revision: updates of definitions (end of sec. 2), planned test dataset years (sec. 4), schedule for validation documents (sec. 9)
2.1	28.08.202	Minor revision according to RIDs raised by ESA
3.0	23.09.2021	Minor revision showing latest PVIR examples (images, tables, metrics)
Aerosol_cci+ Phase 2		
4.0	14.07.2025	Update of the document for Phase 2
4.1	29.08.2025	Review and corrections by project partners

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1 INTRODUCTION

Algorithm evaluation (validation and inter-comparison) is one major part of Aerosol_cci+ activities to benchmark the performance of the two algorithms (SU, CISAR) under evolution in this project and in particular to quantify changes (improvements) against the earlier algorithm versions.

1.1 Scope

This document describes the validation plan for the two algorithms at the start of Aerosol_cci+ Phase 2 project.

1.1.1 Applicable Documents

- [AD1] Request for CCN proposal ESA-EOP-SC-AMT-2021-47: "Aerosol_cci+ Phase 2"
- [AD2] its Annex B: Aerosol
- [AD3] The Prime Contractor's Baseline proposal, ref. 3032766, v1.1 dated 16.04.2025

1.1.2 Reference Documents

- [RD1] GCOS-245, "The 2022 GCOS ECVs Requirements", WMO, Geneva, 2022

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1 DEFINITIONS AND ABBREVIATIONS

Aerosol data products / parameters

AOD: The Aerosol Optical Depth is a non-dimensional quantity for aerosol column amount. AOD is spectrally dependent and refers here to the mid-visible wavelength of 550nm, if not noted otherwise.

ANG: The Ångström parameter is a non-dimensional quantity which contains general information on aerosol particle size. It builds on the AOD solar (spectral) dependence of the AOD and is defined by the negative slope in $[\log(\text{AOD}) / \log(\text{wavelength})]$ space. As an initial guess, $\text{ANG} > 1.3$ indicates the dominance of sub-micron and $\text{ANG} < 0.7$ the dominance of super-micron sizes.

SSA: The Single Scattering Albedo is a non-dimensional quantity and indicates the probability of scattering for an attenuation (scattering and absorption) event. Alternately, the co-single scattering albedo (**coSSA** = $1 - \text{SSA}$) defines the absorption potential.

AAOD: The Absorption Aerosol Optical Depth is product of AOD and coSSA (see definitions above). The AAOD is a quantitative measure for absorption (in the atmospheric column).

FMAOD (Fine Mode AOD, also FM-AOD or AOD_f) is the part of the total AOD which is contributed by fine mode aerosol particles. This quantity (and its optically defined fraction of the total AOD) depend both on wavelength; usually FMAOD at 550 nm is provided. When AOD at 4 wavelengths is available (e.g. from AERONET or some satellite retrievals), FMAOD can be inferred from it with the SDA algorithm. The fine-mode Aerosol Optical Depth is the product of AOD and FMF and defines the actual AOD associated with sub-micron aerosol.

FMF (Fine Mode Fraction) is the fraction of the total AOD which is contributed by aerosol particles smaller than 1µm in diameter. Due to their smaller size these aerosol particles are referred to as fine-mode aerosol, in contrast to larger or coarse model aerosol particles. This quantity is defined microphysically and independent of any measurement wavelength.

AI: The Aerosol Index is a qualitative measure to indicate aerosol potential to serve as cloud condensation nuclei. AI is defined by the product of AOD and ANG (see definitions above).

AAI: The Absorbing Aerosol Index is a qualitative measure to identify the presence of elevated absorbing aerosol (by biomass burning or dust). It is based on retrievals at two wavelengths in the UV and builds on deviations from the molecular UV spectral dependence. With secondary information on aerosol altitude, quantitative links to AAOD are possible.

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Ground-based aerosol remote sensing (at cloud-free conditions)

AERONET: The AERONET (AErosol RObotic NETwork) program is a federation of ground-based remote sensing aerosol sun-/sky-photometer (<http://aeronet.gsfc.nasa.gov/>). Currently there are more than 200 instruments operating worldwide.

MAN: Maritime Aerosol Network, which is a component of the AERONET. MAN deploys Microtops handheld Sun photometers and utilises the calibration procedure and data processing traceable to AERONET

Satellite-based aerosol remote sensing (at cloud-free conditions)

MODIS: The Moderate Resolution Imaging Spectroradiometer is a key sensor dedicated to clouds and aerosol aboard the Terra platform (morning daytime overpass) and the Aqua platform (afternoon daytime overpass). MODIS provides global coverage every one to two days. Retrieved aerosol products are the mid-visible AOD globally and ANG over oceans. The latest retrieval version is collection 6.1 with also contains a complimentary deep-blue retrieval for the AOD over desert areas, where the standard land retrieval fails.

MISR: The Multi-angle Imaging SpectroRadiometer is a key sensor dedicated to aerosol and clouds aboard the Terra platform (morning daytime overpass). MISR provides global coverage only every nine days. With multi-viewing capabilities for the same scene, MISR provide AOD data globally (even over deserts) and also gives estimates for aerosol size via ANG and absorption via AAOD. The latest retrieval version is collection v23.

POLDER: The POLarization and Directionality of the Earth's Reflectances) is a key sensor dedicated to cloud and aerosol aboard the Parasol satellite, which flies in formation with the A-train formation including Aqua and CALIOP (afternoon daytime overpass). POLDER provides global coverage every one to two days. The retrieved aerosol products are primarily AOD and ANG over oceans. Moreover, polarization capabilities allow estimates of dust AOD over oceans and fAOD over continents. This instrument was operated 2005 – 2013 and can thus only be used for comparison with AATSR, not with SLSTR.

CALIOP: The Cloud-Aerosol Lidar with Orthogonal Polarisation is a spaceborne lidar aboard the CALIPSO satellite, which in 2006-2024 has been in formation with the A-train, including Aqua and PARASOL (afternoon daytime overpass). CALIOP provides profiles of the backscatter by aerosols and optically thin clouds on a very narrow path with a 16-day repeat cycle. The retrieved properties include the mid-visible AOD and the AOD stratification into stratospheric and tropospheric layers.

VIIRS: The Visible Infrared Imaging Radiometer Suite (VIIRS) instrument on board the Suomi National Polar-orbiting Partnership (S-NPP) spacecraft was launched in October 2011. VIIRS was designed to match the precedent established by NASA's EOS MODIS-family instruments. It collects imagery and radiometric measurements of the land, atmosphere, cryosphere, and oceans in the visible and infrared bands of the electromagnetic spectrum. The swath width of 3060km allows providing complete coverage of Earth across the day. VIIRS provides a key set of aerosol parameters which is expected to be used in climate and air quality research. With its afternoon orbit,

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comparison to AATSR and SLSTR (morning orbit) can only be done with certain limitations, i.e. neglecting diurnal patterns / allowing 3-4 hour time differences.

CAMS AOD: Aerosol optical depth at 550 nm provided by the Copernicus Atmosphere Monitoring Service)

EUMETSAT SLSTR AOD: The Copernicus Sentinel-3 (S3) NRT AOD product (<https://data.eumetsat.int/product/EO:EUM:DAT:0416>) quantifies the abundance of aerosol particles, and monitors their global distribution & long-range transport, at the scale of 9.5 x 9.5 km².

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2 DESCRIPTION OF VALIDATION ACTIVITIES

The validation activities are two-fold. Foremost are product evaluations against trusted (high-quality) reference data, as they are provided by ground-based sun-photometry. The other important validation aspect are inter-comparisons to already existing and established products from satellite remote sensing, as those products already have undergone evaluations of their own.

The Aerosol_cci+ Phase 2 project focuses on test datasets from the dual view sensor line (ATSR-2, AATSR, SLSTR) with highest priority to the latest instrument (SLSTR), but also assessing the earlier instruments to prepare for high quality integrated data records. Two different algorithms (SU by Swansea university and RF by Rayference) based on Aerosol_cci heritage) will be validated with AERONET and evaluated with other satellite products.

The evaluation of Aerosol_cci+ Phase 2 data products will be done independently by two partners (DLR, FMI) not involved in developing the algorithms used to process the datasets. Both partners have complementary tasks.

The specific partner activities are:

DLR will conduct comparisons to ground-based reference datasets from sun photometer networks AERONET and MAN (WP 3100). DLR will focus on level2 validation, which is closest to the retrieval products and therefore provides direct insight into the quality of the products. For each dataset version per algorithm and sensor, DLR will conduct matching to AERONET / MAN measurements (newest version 3 with better coverage of high AOD cases and uncertainty estimates to rule out stations / observations with weaker data) within ± 30 minutes and ± 50 km and then extract statistical quantities (correlation, bias, rmse, fraction of pixels within GCOS requirement, as shown for bias and rmse in one example in figure 1 as function of AOD) for AOD and fine mode AOD. Additionally, estimated pixel-level uncertainties will be evaluated (WP 3300). This will be done by comparison of histograms of errors calculated from those uncertainties to histograms of the estimated true error (difference between satellite and AERONET AOD) to assess the quality of the uncertainties, as shown in Figure 2. All these analysis tasks will be stratified (land, ocean, regionally, aerosol and environmental conditions) as far as feasible with the available data amounts. Note that the GCOS fraction is only defined for AOD and not for FMAOD or other variables. As far as the data volume allows, we will also split into low and high AOD ranges (below / above 0.2). We furthermore extended the validation standard for pixel-level uncertainties as discussed further in AEROSAT in order to assess their capabilities in more detail (Sayer Andrew M., Yves Govaerts, Pekka Kolmonen, Antti Lipponen, Marta Luffarelli, Tero Mielonen, Falguni Patadia, Thomas Popp, Adam C. Povey, Kerstin Stebel, and Marcin L. Witek, A review and framework for the evaluation of pixel-level uncertainty estimates in satellite aerosol remote sensing, Atmos. Meas. Tech., 13, 373–404, 2020, doi:10.5194/amt-13-373-2020) and shown with 2 examples from this paper on the right side of fig. 2.

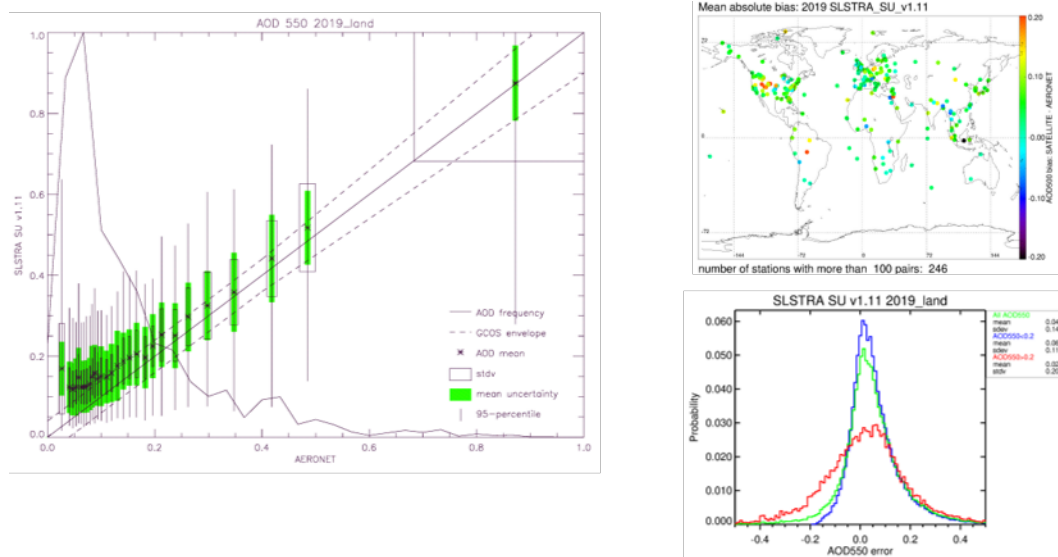


Figure 1: Example level2 validation for SLSTR-3A (SU algorithm v1.11) over land 2019: binned bias / rmse as function of AOD, station map of bias, error histograms for low / high AOD

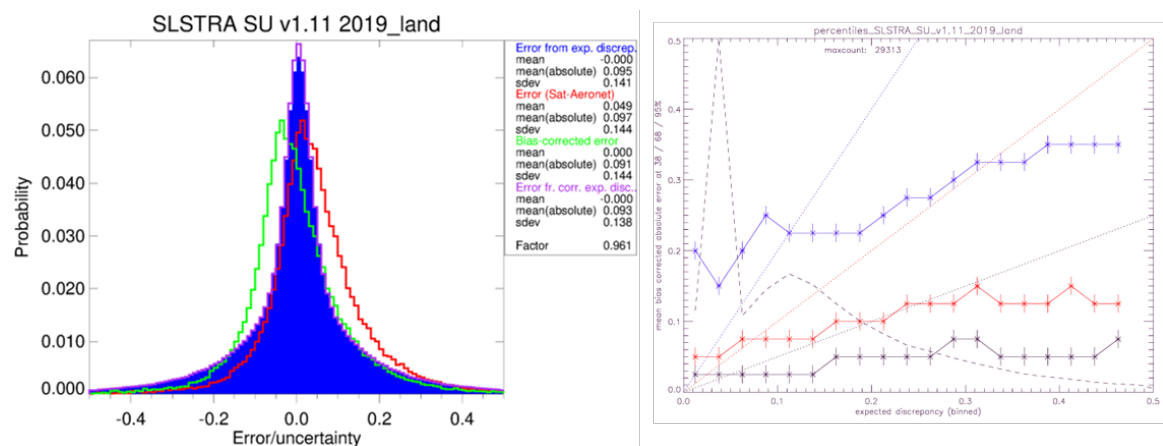


Figure 2: Example level2 uncertainty validation: in Aerosol_cci+ for SLSTR-3A (SU algorithm v1.11) over land 2019: error histogram comparison (left) and percentile analysis (right).

FMI will compare the retrieved datasets with aerosol datasets from other leading aerosol sensors (e.g., MODIS, POLDER) and other SLSTR products (e.g., EUMETSAT operational SLSTR aerosol product) in WP 3200). The inter-comparison of the L2 product will be performed for different regions, which are characterised with different aerosol types (e.g., dust, biomass burning), aerosol loading (clean vs. polluted) and surface types (e.g., ocean, dark forest, desert). Differences in the retrieved and calculated properties will be examined as acceptable discrepancy based on combined GCOS accuracy requirements (as in Tab. 1) and on monthly/regional scale (as in Fig. 4). AOD and ANG spatial differences, as well as their coverage, will also be examined globally (as in Fig. 5 for L3 product).

Table 1. Relative AOD difference between AATSR and MODIS, MISR and POLDER monthly AOD for regions, for year 2008. Cases with RD>1 (AOD difference is outside the acceptable difference) are coloured; legend below the table.

regions	Eur	Bor	AsN	AsW	AsE	ChinaSE	Aus	AfN	AfS	SA	NAW	NAE	Ind	AOd	AOB	InO	PO	Land	Ocean	Globe
March																				
AATSR-MODIS	-0.97	-0.68	-2.38	-0.38	-1.50	-2.24	2.71	0.40	0.94	1.18	0.21	-0.24	-1.23	-1.93	-1.37	-1.20	-1.23	0.16	-1.13	-0.80
AATSR-MISR	-0.28	-0.64	-0.31	0.97	1.14	0.45	2.33	1.22	0.63	1.93	0.59	-0.45	0.24	-0.99	0.09	0.07	0.12	1.13	-0.16	0.14
AATSR-POLDER	-1.77	-2.92	-2.17	0.63	-0.97	-1.95	2.64	2.22	-1.57	2.05	-0.90	-0.35	0.28	-0.80	-0.24	-0.12	0.12	0.16	-0.19	-0.07
June																				
AATSR-MODIS	-1.81	-0.99	-1.41	-2.43	-1.66	-1.92	3.13	1.12	1.01	2.88	-1.32	-0.90	-1.25	-3.00	-1.20	-0.90	-0.90	-0.31	-1.32	-0.87
AATSR-MISR	-0.14	-0.16	-0.21	-0.45	1.55	2.08	2.90	0.42	1.79	3.49	-0.45	-1.01	0.45	-1.44	0.33	-0.31	0.02	0.68	-0.19	0.19
AATSR-POLDER	0.02	-0.97	-0.82	0.84	-1.68	-1.28	3.25	3.28	0.49	3.37	-1.53	-0.73	0.14	-1.56	-0.49	-0.40	-0.12	0.64	-0.45	-0.02
September																				
AATSR-MODIS	-0.38	-0.54	-0.07	-0.97	-0.53	-0.59	3.42	0.92	0.93	1.89	-0.57	-0.59	-1.70	-2.00	-3.71	-1.20	-1.20	0.52	-1.30	-0.73
AATSR-MISR	0.85	-0.07	0.09	0.66	1.73	1.60	2.31	0.92	1.16	2.47	0.45	-0.31	0.42	-0.66	-0.49	0.05	-0.05	1.13	-0.14	0.26
AATSR-POLDER	-0.05	-0.82	-0.12	-0.82	-0.43	0.14	2.66	0.87	-1.66	1.34	-0.09	-0.40	0.16	-0.73	-2.00	-0.05	0.12	0.19	-0.09	0.02
December																				
AATSR-MODIS	-1.01	NaN	-1.20	0.66	-0.73	-1.07	1.74	0.00	1.39	1.37	0.00	-0.09	-1.08	-1.23	-1.91	-1.23	-1.04	0.80	-1.18	-0.75
AATSR-MISR	-0.31	NaN	-0.47	1.91	1.72	1.81	0.75	0.52	0.64	1.53	0.49	0.09	0.38	0.00	-0.45	-0.05	0.09	1.25	-0.14	0.14
AATSR-POLDER	-0.73	NaN	-2.07	1.37	-1.03	-1.34	1.58	0.19	-1.73	1.63	-0.14	-0.21	0.28	-0.47	-1.18	0.07	0.28	0.26	0.09	0.14
						RD	<-2.0	<-1.5	<-1.0				>1.0	>1.5	>2.0					
						Group	Ng3	Ng2	Ng1				Pg1	Pg2	Pg3					

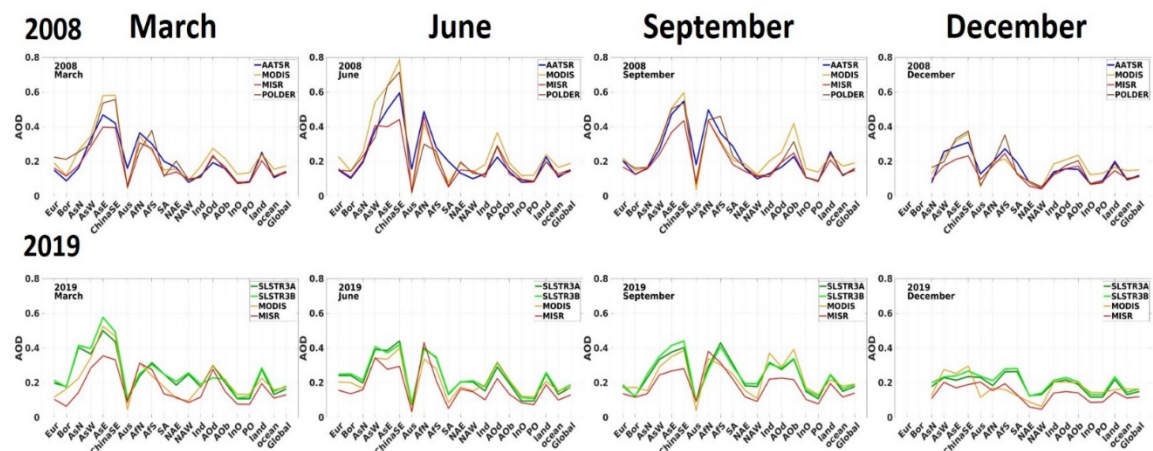


Figure 3. Monthly AOD for AATSR, MODIS, MISR and POLDER (2008, upper panel) and for S3A, S3B, MODIS and MISR (2019, lower panel) for different regions.

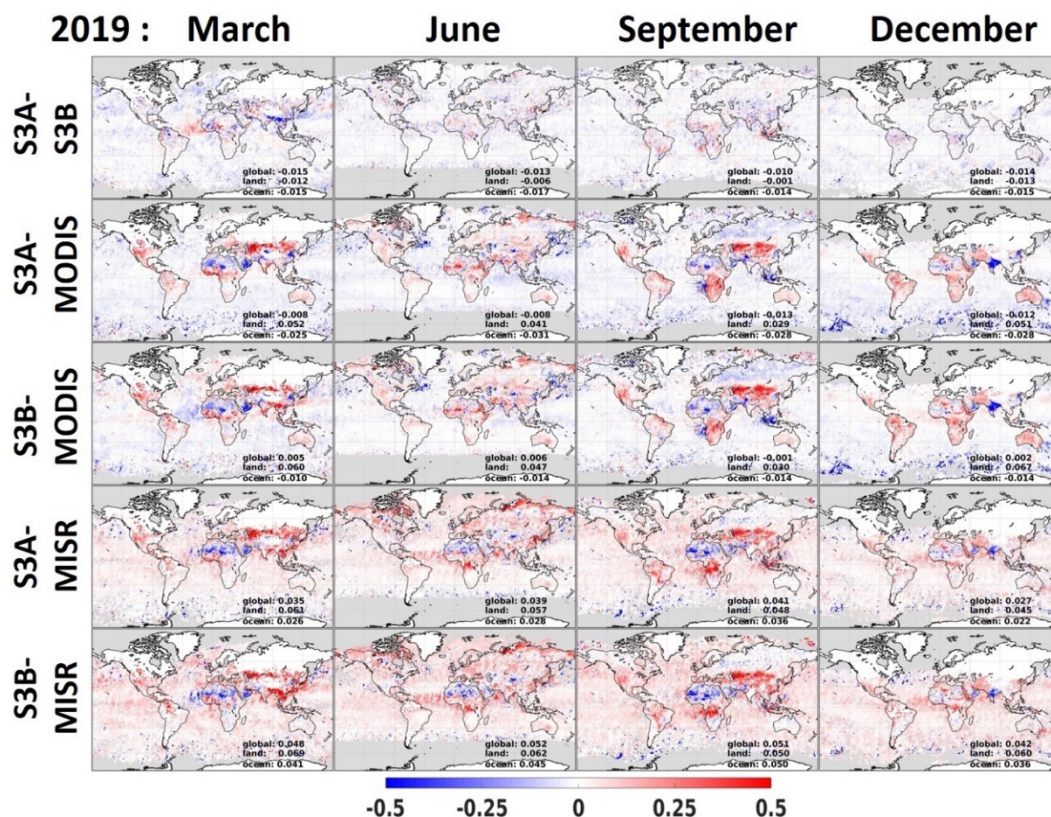


Figure 4. Example L3 seasonal AOD difference between SLSTR 3A and 3B SU v1.11 and MODIS and MISR onboard Terra

In the second year inter-comparisons will also include the latest SLSTR products from EUMETSAT, so that we can directly relate the performance of the different algorithms.

For POLDER and VIIRS (both afternoon orbits), comparisons make sense only for gridded spatially averaged daily data due to the difference in overpass time between morning and afternoon. FMI may also involve MISR data (new version v23).

Validation will be conducted 1) for global datasets covering 4 months of four different seasons (initial development cycle), and 2) in the final development cycle covering a full year of global data. Validation will assess such datasets from ATSR-2 and AATSR (Swansea algorithm) and of the SLSTR onboard Sentinel-3A. To allow inter-comparisons of the results between different algorithm versions and between the two algorithms, we will make sure to use identical reference datasets and cover identical (sub) periods.

Validation will focus on AOD and FineMode AOD, but also analyse for diagnostic purposes other aerosol variables (dust AOD, absorbing AOD) and surface reflectance co-retrieved.

In this project we will not cover validation of gridded level3 products as this is done by MetNo in the C3S2_313a contract for atmospheric composition / aerosols. We will also not conduct any stability analysis (impossible with only one-year datasets) which is also done in the C3S2_313a contract by MetNo.

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For evaluations of retrieval skill, aside from side-by-side comparisons and difference plots, the following metrics will be used:

Pearson correlation coefficient **K**

$$K = \frac{\sum_{i=1}^N (x_{Sat} - \langle x_{Sat} \rangle)(x_{AER} - \langle x_{AER} \rangle)}{\sqrt{\sum_{i=1}^N (x_{Sat} - \langle x_{Sat} \rangle)^2 \sum_{i=1}^N (x_{AER} - \langle x_{AER} \rangle)^2}}$$

root mean square error **RMSE** or *rms*

$$RMSE = \sqrt{\frac{\sum_{i=1}^N (x_{Sat} - x_{AER})^2}{N}}$$

standard deviation **STDV**

or bias-corrected RMSE **σ**

$$\sigma = \sqrt{\frac{\sum_{i=1}^N [(x_{Sat} - x_{AER}) - \langle (x_{Sat} - x_{AER}) \rangle]^2}{N}}$$

bias **b** (taken from difference histograms)

$$b = \frac{1}{N} \sum_{i=1}^N (x_{SAT} - x_{AER})$$

linear fit gradient **g**

$$g = \frac{\sum_{i=1}^N (x_{AER} - \langle x_{AER} \rangle) \cdot (x_{SAT} - \langle x_{SAT} \rangle)}{\sum_{i=1}^N (x_{AER} - \langle x_{AER} \rangle)^2}$$

linear fit offset **o**

$$o = \langle x_{SAT} \rangle - g \cdot \langle x_{AER} \rangle$$

For AOD only:

GCOS fraction **f_{GCOS}** % with $|x_{Sat} - x_{Aer}| < \max(0.06; 20\%)$
This matches the 2-sigma uncertainty threshold criterion according to GCOS-245 (2022) ECV requirements.

Bias corrected GCOS fraction **f_{GCOS}** % with $|x_{Sat} - x_{Aer} - b| < \max(0.06; 20\%)$

Adapted GCOS envelope (a, b) 95,4% where $|x_{Sat} - x_{Aer}| < \max(a; b\%)$
In order to qualify a dataset similar to the GCOS envelope, we iteratively fit the smallest possible envelope which contains 95,4% of the errors of all pixels (in steps of 0.01 and 3.3% rounded), which we name "Adapted GCOS envelope".

For prognostic uncertainty validation:

Expected discrepancy **ϵ_T**

$$\epsilon_T = \sqrt{[\epsilon_{Sat}^2 + \epsilon_{Aeronet}^2]}$$

Normalized error **Δ**

$$\Delta = (AOD_{Sat} - AOD_{Aeronet}) / \epsilon_T$$

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Acceptable discrepancy

$AD = \sqrt{ae_1^2 + ae_2^2}$, where ae_1 and ae_2 are accepted errors for the inter-compared AOD products 1 (AOD₁, product for evaluation) and 2 (AOD₂, reference product), respectively.

In the above formulas x_{Sat} corresponds to satellite test data ***D*** and x_{AER} corresponds to the matching reference data ***R***. $\langle x \rangle$ is the average value and N is the number of data pairs. The "bias corrected RMSE" subtracts the average bias from each point before calculating the sum of the squared differences.

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3 MASTER SCHEDULE

The validation master schedule in Aerosol_cci+ Phase 2 is provided in table 3.1.

Table 2 Validation master schedule

Validation activity	Dataset production	Dataset analysis	validation deadline	Validation output
First development cycle (4 months of test data only)				
CRDP v1.0	Mar 2026	June 2026	30/06/2026	PVIR, v1.0
Second development cycle (12 months of test data)				
CRDP v2.0	Sep 2026	Dec 2026	31/12/2026	PVIR, v2.0

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4 RESOURCES SUMMARY

The evaluations will primarily build on already existing tools at DLR and FMI (used for their own dataset evaluation and for qualifying ensemble member uncertainties). The required reference datasets are openly available from their providers.

In order to be able to somehow assess aerosol evolution in decadal steps we propose following years for the CRDP of this project: 1998 (ATSR-2), 2008 for AATSR and 2020 for SLSTR. The test data year for SLSTR will be discussed and finalized at the first progress meeting (8 September 2025).

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5 RULES FOR UNBIASED VALIDATION

The evaluations will be performed by partners not directly involved in developing the concerned retrieval algorithms or processing the test datasets. This is to assure that personal interest does not favor particular retrievals when ranking retrieval performance for identical products from the same satellite sensor in competitions among different retrieval groups.

Also data used in the 'tuning' of retrievals and the retrieval model need to be excluded as data references.

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6 VALIDATION CRITERIA

Generally statistical methods are employed in data evaluations against trusted references or in comparisons to other already evaluated products. Hereby, also uncertainties of the reference data will be considered. Assessments of individual cases will at best be supplementary in nature, since retrieval assessments are required for a wide variety of different environments.

The statistical measures involve basic properties such as bias and variability (whose sum is usually captured by the root mean square error (RMSE)). Hereby, variability aspects distinguish between spatial variability at an instance as well as local variability in time. These will be the primary validation criteria for quantitative performance scores.

For visual examinations, also difference maps between spatial datasets (Aerosol_cci+ and other satellite data) will be considered to judge capabilities to observe expected seasonal and regional patterns. Finally, also spatial and temporal coverage (by the number of matching pairs with a reference dataset) will be taken into account.

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7 REVIEW PROCESS AND USE OF VALIDATION

Newly developed aerosol retrieval products will be placed on an ftp server (for consistency, we keep using the ICARE server, where all Aerosol_cci and C3S aerosol datasets have been archived), which is accessible by validation partners. The partners evaluate the new data products independently against trusted references from remote sensing with their own (graphical and quantitative) tools. Both validation partners will prepare a validation and intercomparison summary report (Which will later become the PVIR) about retrieval performances, illustrating strengths and limitations. This will help determining the needs for algorithm improvements and identifying where these need to be developed. The PVIRs will be provided to the algorithm teams for analysis and review before completion.

The two validation partners will take great care to be consistent in their analysis methods, definition of statistical diagnostics, and use of vocabulary.

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8 REFERENCE DATA

Reference data are primarily sun- (and sky-) photometer samples from AERONET version 3 and MAN (ship tracks). The accuracy of AERONET AOD values is considered as 0.01 and thus typically much better than satellite retrievals. Properties such as FMAOD (provided by the SDA algorithm) may have somewhat larger uncertainties but still smaller than satellite estimates of this quantity. For properties such as SSA, also AERONET exhibits significant uncertainties, which get larger for low AOD values; therefore, we prefer to compare AAOD.

Concerning other satellite datasets, we plan to use most established datasets such as MODIS collection 6.1 (the long-term standard product), MISR v23 (higher skill due to multi-angular view, but weaker coverage), VIIRS (MODIS continuation) and POLDER (largest self-consistent information content of aerosol variables, for AATSR only) – POLDER and VIIRS can only be used on Level3 of gridded data (morning vs. afternoon orbits). We will also test the value of comparisons with satellite lidars (active retrievals with highest accuracy, but remaining issues such as saturation over bright surfaces which can lead to missing part of the total AOD).

9 VALIDATION DOCUMENTS

Validation documents will be prepared by the validation partners to summarize evaluation efforts by the validation teams and to highlight for the two retrieval products their strengths and limitations, while also providing recommendations for retrieval applications (e.g. preferred regions and/or time).

All validation documents, when completed, will be shared with the providers to stimulate further algorithm developments. After internal approval by ESA and the consortium, the validation documents will become public and made accessible via the Aerosol_cci website at ESA, also in an effort to get immediate feedback and suggestions from other CCI groups, CMUG and the remote sensing (e.g. AEROSAT) and modelling community at large, including potential data users like C3S, CAMS or AeroCom.

A summary of validation documents is provided in table 9.1.

Table 3 Validation and related documents

Del. No.	deliverable	Due date	comment
D1.3	Product validation plan PVP	July 2025 March 2026	this document
D4.1	Product validation and intercomparison report PVIR	June 2026 December 2026	

Excerpts of the PVIR will be summarized in the Product User Guide and the Climate Assessment Report (together with brief dataset reviews by core users). We intend to write one peer-reviewed publication about the algorithm improvements as documented by dataset validation and inter-comparisons.

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10 GETTING ENDORSEMENTS

The evaluations concepts and results are based on common practices of the satellite aerosol retrieval community and are part of the discussions in AEROSAT with retrieval specialists from outside this project.

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