

ACTRIS-EARLINET Quality Control Procedures:

Version 4.0

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2.0	25/03/2021	Inclusion of new basic and advanced quality controls	Francesco Amato
3.0	25/03/2024	Added Multiproduct Quality Control	Pilar Gumà-Claramunt
4.0	25/02/2025	Added new implementations of version 4 of the quality controls	Pilar Gumà-Claramunt



1 INTRODUCTION

Data quality control procedures for the ACTRIS-EARLINET database have improved over time. This document reports on the automatic quality check procedures currently working on the ACTRIS-EARLINET database.

When a product is submitted to the ACTRIS-EARLINET database the following steps are applied by the ARES Data Center:

- 1. technical quality controls (BQC) are executed to ensure the product is compliant from the technical point of view according to the defined standard
- 2. advanced quality controls (AQC) are executed to assess the quality from a physical point of view of the product
- 3. [optional] multi-product quality controls (MPQC) are executed to assess the quality from a physical point of view of the product, by comparing different products within the same measurement. This step can only be applied to the products that are being submitted automatically from the SCC (Single Calculus Chain, the official analysis tool of the network)
- 4. the results of the previous three steps are stored in the database
- 5. the product is renamed according to the filename conventions and stored in the datacenter

The products that do not pass step 1 are not accepted by the data center and a corresponding error message is shown to the data originator.

Afterwards, the distinction between manually and automatically uploaded products needs to be made.

The manually uploaded products that pass step 1 but not step 2 are accepted by the datacenter and labelled as Level 1 products. When they pass both steps 1 and 2, the products are accepted by the datacenter and labelled as Level 2 products.

The automatically uploaded products are labeled as Level 2 products if they pass steps 1, 2 and 3. Otherwise, they are labelled Level 1 products.

Both Level 1 and Level 2 products are made public as soon as they are accepted by the data center. This means that a product, once submitted and accepted by the data center (independently of the assigned level), cannot be deleted.

It is possible to submit a new version of an already submitted product only during specific time windows, which are communicated by the data center administrators. A specific Record Version Control system has been developed to allow multiple versions of the same product. This is a primary and necessary tool both for data originators and end-users. Indeed, sometimes it can happen that data originators may realize that something is wrong or not optimized in the products already uploaded on database.



Besides, if a new version of the retrieval algorithm is released, for example with a new SCC version release, products need to be re-analyzed. If a product submitted is a new version of an already uploaded product, it will be only accepted during a versioning window. The submission of new product versions is not possible outside these specific time slots.

Starting from version 3.0, the Quality Control procedures are carried out exclusively *on-fly* during the upload process.

Quantity	Description
β	aerosol backscatter coefficient
Δβ	error on aerosol backscatter coefficient
β _{peak} (λ)	aerosol backscatter peak depending on wavelength
β_{dect}	aerosol backscatter detection limit
β_{th}	aerosol backscatter threshold value
α	aerosol extinction coefficient
Δα	error on aerosol extinction coefficient
α _{peak} (λ)	aerosol extinction peak depending on wavelength
α_{dect}	aerosol extinction minimum aerosol layer detection limit
α_{th}	aerosol extinction threshold value
S	lidar ratio
ΔS	error on lidar ratio
dh	aerosol layer height : defined as the lowest layer that generally contains most of the aerosol except special elevated layers (like Saharan dust etc.)
IB	Integrated aerosol backscatter
AOD	Aerosol optical depth

The following table reports quantities that are used by the different quality controls:

Next, all the quality controls are described in detail.



2 BASIC QUALITY CONTROLS

2.1 BQC-00

This procedure checks that each file contains the mandatory products. The mandatory products are the following:

Product type	Mandatory variables
Backscatter (b-file)	β (backscatter)
	Δβ (error_backscatter)
Extinction (e-file)	A (extinction)
	Δα (error_extinction)

Moreover, these mandatory variables must not be *NaN, NULL* or *negative defined* (they must contain at least 1 valid value).

If BQC-00 fails, the interface will generate the following types of errors:

- Missing [backscatter] Variable. Missing [error_backscatter] Variable.
- backscatter: empty variable.
- backscatter : variable has all NaN elements. backscatter : whole defined Negative Variable.

2.2 BQC-01

This procedure checks that *all the array variables* present contain data. They cannot be empty or contain only undefined or negative values.

If BQC-01 fails, the interface will generate the following types of errors:

- vertical_resolution : empty variable.
- vertical_resolution : variable has all NaN elements.
- vertical_resolution : whole defined Negative Variable
- vertical_resolution : value not allowed

2.3 BQC-02

If the MixingLayerHeight (*mh*) is present, the Aerosol Layer Height *dh* must also be present.

If BQC-02 fails, the interface will generate the following error:



• "mixinglayerheight exists but aerosollayerheight is Missing."

This control is related to the definition of mixinglayerheight and aerosollayerheight (previously named dust layer height) as reported at <u>https://www.earlinet.org/index.php?id=125</u>.

2.4 BQC-03

The MixingLayerHeight, if present, must be lower than or equal to the Aerosol LayerHeight. The following condition must always be preserved:

mh≤dh

If BQC-03 fails, the interface will generate an error such as:

• "mixinglayerheight higher than aerosollayerheight."

This control is related to the definition of *mixinglayerheight* and *aerosollayerheight* (previously named dust layer height), as reported at <u>https://www.earlinet.org/index.php?id=125</u>.

2.5 BQC-04

The AerosolLayerHeight *dh*, if present, must be higher than the station altitude:

dh>station_altitude

The MixingLayerHeight *mh, if present,* must be higher than the station altitude:

mh>station_altitude

If BQC-04 fails, the interface will generate the following types of error:

- "aerosollayerheight is lower than station Altitude"
- "mixinglayerheight is lower than station Altitude"

2.6 BQC-05

If the following variables are present in the data file a control must be carried out:

• If volumedepolarization is present, error_volumedepolarization must be present as well



- If particledepolarization is present, error_particledepolarization must be present as well
- If *watervapormixingratio* is present, *error_watervapor* must be present as well

If BQC-05 fails, the interface will generate the following types of errors:

- "volumedepolarization exists but error_volumedepolarization is Missing."
- "error_volumedepolarization exists but volumedepolarization is Missing."
- "volumedepolarization and error_volumedepolarization have different size."
- "particledepolarization exists but error_particledepolarization is Missing."
- "error_particledepolarization exists but particledepolarization is Missing."
- "particledepolarization and error_particledepolarization have different size."
- "watervapormixingratio exists but error_watervapor is Missing."
- "error_watervapor exists but watervapormixingratio is Missing."
- "watervapormixingratio and error_watervapor have different size."

2.7 BQC-06

The following *BYTE* and *FLOAT* variables are *MANDATORY* for the products whose attribute *measurement_start_datetime* is greater than 2019-06-24, the release date of the new database, with these specifications and constraints :

- byte atmospheric_molecular_calculation_source ALWAYS MANDATORY
- byte error_retrieval_method(wavelength) ALWAYS MANDATORY

if Backscatter is present :

- byte backscatter_evaluation_method(wavelength) IS MANDATORY
- if backscatter_evaluation_method = 0 then
 - the variable byte raman_backscatter_algorithm(wavelength) IS
 MANDATORY
 - else if backscatter_evaluation_method = 1 then the variable byte elastic_backscatter_algorithm(wavelength) IS MANDATORY
- byte backscatter_calibration_range_search_algorithm(wavelength) IS MANDATORY
- float backscatter_calibration_value(wavelength) IS MANDATORY
- float backscatter_calibration_search_range(wavelength, nv) IS MANDATORY
- float backscatter_calibration_range(wavelength, nv) IS MANDATORY

If Extinction is present :



• byte extinction_evaluation_algorithm(wavelength) IS MANDATORY

If BQC-06 fails, the interface will generate an error such as:

• "Mandatory variable missing."

For example :

• atmospheric_molecular_calculation_source : Mandatory variable missing.

2.8 BQC-07

For each declared BYTE variable, its *VALUES* are checked. Allowed values are retrieved from thevariable *flag_values* attribute.

If BQC-07 fails, the interface will generate the following types of errors :

• "value not allowed."

E.g.:

• cirrus_contamination : value not allowed. cirrus_contamination = 8

2.9 BQC-08

The following *global attributes* are *MANDATORY* for the products whose attribute *measurement_start_datetime* is greater than 2019-06-24, the release date of the new database:

Name	Туре
processor_name	string
PI	string
PI_affiliation	string
PI_email	string
Data_Originator	string
Data_Originator_affiliation	string
Data_Originator_email	string
hoi_system_ID	integer
hoi_configuration_ID	integer
Conventions	string
title	string
source	string
references	string



Name	Туре
history	string
station_ID	string
location	string
system	string
institution	string
comment	string
measurement_start_datetime	string
measurement_stop_datetime	string

If BQC-08 fails, the interface will generate the following types of error:

• "Mandatory global attribute missing."

E.g.:

• measurement_start_datetime : Mandatory global attribute missing.

2.10BQC-09

Validation of *measurement_start_datetime* and *measurement_stop_datetime* global attributes. A control is performed to check if *measurement_start_datetime* and *measurement_stop_datetime* global attributes represent a valid date time and they are also compared with the actual date time to avoid inconsistencies (e.g. a date time in the future). Moreover, a control is made over the variable *time* to ensure consistency. The *time* variable cannot have values less than 1997-12-01 (which represents approximately the date on which the first file was uploaded to the network database) and greater than the current date.

If BQC-09 fails, the interface will generate the following types of errors :

- "Variable [time] value is NOT valid."
- "Global attribute [measurement_start_datetime] is NOT valid." "Global attribute [measurement_stop_datetime] is NOT valid."
- "[measurement_start_datetime] is greater than the [measurement_stop_datetime]" "[measurement_start_datetime] is equal to [measurement_stop_datetime]"

For example:

• //ERROR Variable [time] value is NOT valid. : time[0] = 1 Value is less than 1997-12-01



2.11 BQC-10

If the NetCDF data file contains the variable _____*SkippedFraction* a control is performed tocheck if its value is between the range [0, 1]

If BQC-10 fails, the interface will generate the following error :

• "SkippedFraction has a wrong value."

2.12BQC-11

This control is performed to check if the station coordinates (*latitude, longitude, altitude*) are correct within the errors :

- latitude ±0.05°
- longitude± 0.05°
- altitude± 60m

This control does not apply to mobile stations.

If BQC-11 fails, the interface will generate the following types of errors:

- "Location [Latitude] is Wrong."
- "Location [Longitude] is Wrong.""Location [Altitude] is Wrong."

2.13BQC-12

This control checks that the *altitude* variable is not less than 0*m asl* and is not greater than athreshold value of *50km* (top of troposphere).

If BQC-12 fails, the interface will generate the following types of errors :

• "Altitude value out of limits"

For example:

- Altitude value out of limits : altitude[6] = -60
- Altitude value out of limits : altitude[226] = 9.96921e+36



2.14 FURTHER TECHNICAL CONSIDERATIONS

Since every product in the network is a NetCDF file, when a product is uploaded its integrity is verified. This means that a data file must be compliant with the <u>NetCDF data</u> <u>format</u>.

If a product is not compliant with the NetCDF data format, the interface can generate a series of errors all related to data format. The explanation of each of these errors can be found at <u>https://www.unidata.ucar.edu</u>.

The following types of errors, reported by the upload interface, are the most common faced by the users and they are all well documented on the official website above cited:

- "nc_open File Failed. Likely, the file you submitted is not a NetCDF file."
- "nc_create File Failed."
- "nc_inq Failed."
- "nc_inq_dimlen Failed."
- "nc_inq_dimid Failed."
- "nc_inq_varname Failed."
- "nc_inq_varid Failed."
- "nc_inq_var Failed."
- "nc_get_var_float Failed."
- "nc_get_var_double Failed."
- "nc_get_var_int Failed."
- "nc_inq_attlen Failed."
- "nc_get_att_double Failed."
- "nc_get_att_text Failed."
- "nc_get_att_int Failed."
- "nc_def_dim Failed."
- "nc_def_var Failed."
- "nc_enddef Failed."
- "nc_put_var_float Failed."
- "nc_put_var_int Failed."
- "nc_put_att_text Failed."
- "nc_put_att_float Failed."
- "nc_put_att_int Failed."



Common interface feedback messages (exit codes) users have problems with :





3 ADVANCED QUALITY CONTROLS

3.1 AQC-00

This control scans the optical properties profiles to check that their corresponding errors are positive for all the defined points. If at least one error point is negative, zero, or not defined, the product file does not pass this QC.

Depending on the kind of product, this control is applied to the couples of variables:

- backscatter error_backscatter
- extinction error_extinction

If AQC-00 fails, the interface will generate the following types of errors:

- "error_backscatter variable is not positive for all defined value of the backscatter"
- "error_extinction variable is not positive for all defined value of the extinction"

3.2 AQC-01

This control performs a profile scanning and checks that the aerosol optical properties are positive within 3σ and that there are not negative peaks. It only allows extreme values if cirrus clouds are present.

If the backscatter is negative, these are the checks performed:

- $\beta + \beta_{th} \ge 0$ OR $|\beta| < 3 \Delta \beta$
- $\beta < \beta_{\text{peak}}(\lambda)$ if it does not belong to cirrus category

If the extinction is negative, these are the checks applied:

- $\alpha + \alpha_{th} \ge 0$ OR $|\alpha| < 3 \Delta \alpha$
- $\alpha < \alpha_{\text{peak}}(\lambda)$ if it does not belong to cirrus category

For a first screening of unrealistic negative peak values, a value representative of an aerosol layer is used. In particular $\beta_{th} = 5 \cdot 10^{-7} m^{-1} sr^{-1}$ and $\alpha_{th} = 2.5 \cdot 10^{-5} m^{-1}$.

These threshold values are set as 50 times the calibration value for the 1064 *nm* channel.



Wavelength and *IB* are scaled in the most conservative way, and the threshold is kept constant over the different wavelengths.

Peak values had been set up studying the *pdf* of optical properties values for cirrus cases: even for cirrus cases the probability of having α > 0.005 m^{-1} is less than 5‰. Correspondingly a $\beta_{\text{peak}}=1.7\cdot10^{-4} m^{-1} sr^{-1}$ was set up assuming a lidar ratio of 30 *sr* (most conservative value).

If AQC-01 fails the interface will generate, for example, error(s) like the following:

- OVER PEAK : bck = 0.000237872 err_bck = 1.17592e-05
- OVER PEAK : bck = 0.00495033 err_bck = 14.322
- OVER PEAK : ext = 0.01091 err_ext = 0.00215
- OVER PEAK : ext = 0.00737 err_ext = 0.00247
- bck = -7.35e-07 err_bck = 1.15e-07 [over 3*Sigma OR over threshold]
- bck = -6.14e-07 err_bck = 1.43e-07 [over 3*Sigma OR over threshold]

where bck and err_bck stand for backscatter and error_backscatter, and ext and err_ext stand for extinction and error_ extinction.

3.3 AQC-02

Integrated quantities of the aerosol properties should be positive and not exceed very extreme values, which is not realistic for aerosol layer cases. Such very high values could occur even in very specific and intense aerosol layers; however, such cases should be treated in a careful way dealing with multiple scattering. For these reasons, cases corresponding to very extreme integrated values are not labelled as Level 2 data, highlightingto data users that care should be taken handling such data.

The *aerosol optical depth AOD* (without any assumption in the lowest troposphere, so evaluated only in the portion of atmosphere covered by the provided profile) should remain under an established threshold for data not belonging to the cirrus category.

- AOD > 0
- *AOD* < *AOD*th if it does not belong to cirrus category

The threshold values AOD_{th} = 1.5 had been set up studying the *pdf* of AOD for cirrus cases available on the EARLINET database until July 2016: even for cirrus cases the probability of having AOD > 1.5 is less than 5‰. The scaling with the wavelength had been set up in the most conservative way: considering that on average over Europe AERONET report 1.1-1.5 as typical Angstrom exponent, the threshold value was scaled with wavelength considering an Angstrom value of 0, so no wavelength dependence at all.



This quality control is applied to extinction files only.

If AQC-02 fails, the interface will generate, for example, errors like the following :

- AOD greater than Threshold value : 75.0141
- AOD greater than Threshold value : 7.00155e+39
- AOD NEGATIVE : -3.3e+08
- AOD UNDEFINED

3.4 AQC-03

As for *AOD*, integrated quantities of the aerosol backscatter should be positive and not exceed values which are not realistic for aerosol layer cases. Such very high values could occur even in very specific and intense aerosol layers; however, such cases should be treated in a careful way dealing with multiple scattering. For these reasons, cases corresponding to very extreme integrated values are not labelled as Level 2 data, highlighting to data users that care should be taken handling such data.

The aerosol *integrated backscatter IB* (without any assumption in the lowest troposphere, so evaluated only in the portion of atmosphere covered by the provided profile) should remain under an established threshold for data not belonging to the cirrus category.

- *IB* > 0
- *IB* < *IB*th if it does not belong to cirrus category

Starting from the AOD_{th} discussed above, the IB_{th} = 0.05 sr-1 is defined assuming a low (30*sr*) lidar ratio value (most conservative choice) for converting extinction into backscatter and an Angstrom of 0 for scaling with the wavelength.

This quality control is applied to backscatter files from QC version 3, and to extinction files which contain backscatter since the QC version 4.

If AQC-03 fails the interface will generate, for example, error(s) like the following:

- IB greater than Threshold value : 1.3629e+250
- IB NEGATIVE : -0.0285286IB NEGATIVE : -0.0278059
- IB UNDEFINED



3.5 AQC-04

This control performs a check on the *Lidar Ratio* values when Extinction and Backscatter are provided in the same product file (i.e. are provided at the same vertical resolution).

Lidarratio is defined as a positive value, and values are typically between 10 and 120 *sr*.

A wider window is defined for excluding non-realistic values without constraining the *pdf* of the *lidarratio* variable values:

S \in [0, 200] *sr* within 3 Δ *S*

However, the lidar ratio is an intensive property so it is defined only where aerosols are significantly present. Therefore, the limit on *S* should be valid only where an aerosol layer is present, so where extinction and/or backscatter exceed a certain value that can be treated as a minimum aerosol layer detection limit and with limited statistical uncertainty.

In particular, the following check is performed:

If $\alpha > \alpha_{dect}(\lambda)$ AND ($\Delta \alpha / \alpha$) < 50% AND If $\beta > \beta_{dect}(\lambda)$ AND ($\Delta \beta / \beta$) < 50%:

S must be between [0, 200]*sr* within 3 Δ *S* with:

 $\beta_{dect} = 5 \cdot 10-7m-1sr-1 \text{ and } \alpha_{dect} = 2.5 \cdot 10-5m-1$

where the uncertainty of *extinction* and *backscatter* is lower than 50%

If AQC-04 fails, the interface will generate the following types of errors :

• "Lidar Ratio value NOT allowable" "Lidar Ratio + (3*errLR) is Negative"

3.6 AQC-05

This control is performed on the *volume depolarization* variable and its error (*error_volumedepolarization*) to check that the following conditions are met:

- |volumedepolarization|< 3 error_volumedepolarization
- volumedepolarization must be between [0, 1] within its error

If AQC-05 fails, the interface will generate, for example, error(s) like the following :

 volumedepolarization = 1.19425 error_volumedepolarization = 0.0472857 - [over 3*Sigma OR overthreshold]



 volumedepolarization = 1.25597 error_volumedepolarization = 0.040426 - [over 3*Sigma OR overthreshold]

3.7 AQC-06

This control is performed on the *particle depolarization* variable and its error (*error_particledepolarization*) to check that the following conditions are preserved :

- |particledepolarization| < 3 error_particledepolarization
- particledepolarization must be between [0, 1] within its error

If AQC-06 fails, the interface will generate, for example, error(s) like the following :

- particledepolarization = -8.0734 error_particledepolarization = 1.91339 [over 3*Sigma OR over threshold]
- particledepolarization = -7.47232 error_particledepolarization = 1.34767 [over 3*Sigma OR over threshold]

3.8 AQC-07

This control is performed on the *water vapor mixing ratio* variable and its error (*error_watervapor*) to check that the following conditions are preserved :

- |watervapormixingratio|<3 error_watervapor
- watervapormixingratio must be between [0, 100 g/Kg] within its error

If AQC-07 fails, the interface will generate errors like the ones reported for AQC-05 an AQC-06.

3.9 AQC-08

The use of standard atmosphere profiles is a source of potentially high error in the optical property profiles. Therefore, data products obtained using such molecular profiles are not considered as high-quality ones and will be labelled as Level 1 data product.

This control is performed on the variable *atmospheric_molecular_calculation_source*. If its value is 0 (*zero – US standard atmosphere*) the product is labelled as *Level 1*. This control will be applied to products whose start time is higher than *202103250000*.



3.10AQC-09

Data products uploaded before the new release of the database (2019-06-24), labeled as cirrus, and not reporting the cloud mask as vertical information are labeled as *Level 1*. This control is implemented as a message to data users of handling such data with care, because a cirrus cloud is present but the location in the vertical dimension of such cloud is not precisely reported into the data product.

If AQC-09 fails, the interface will generate the following types of errors :

• "Product is labelled as cirrus but cloud_mask variable is missing"

3.11 AQC-10

Only data products obtained using the approved configuration into the Single Calculus Chain (i.e. Operational product) can be fully quality controlled products. Experimental products are still useful and interesting products, but the data users should be aware that they are not fully quality controlled in the workflow from performing measurements to the optical data product provision.

This control is performed on the variable *scc_product_type*, and it is applied to products whose start time is higher than *202103250000*.

If scc_product_type = 1, it is an experimental product, and the product is labelled as Level 1.fscc_product_type = 2, it is an operational product, and the product is labelled as Level 2.

If AQC-10 fails, the interface will generate the following types of errors :

• "scc_product_type = 1 the product is experimental"

In case not allowed value is reported (for example x) the following will appear

• "scc_product_type = x value not allowed"

3.12 VARIABLES ADDED BY THE DATABASE PROCESSOR

After all the Quality Control has been applied to a product data file, the Database Processor adds a series of variables to the uploaded product. These variables keep track of quality control level, by including the Basic and Advanced quality controls the product has either passed or failed. The list of variables added by the system at the end of the uploading phase are the following:

- quality_control_level;
- basic_quality_control;
- advanced_quality_control;



4 MULTIPRODUCT QUALITY CONTROLS

To improve the quality of the optical products uploaded automatically into the EARLINET database, the Multiproduct Quality Control procedures have been implemented. These procedures are only applied to the data submitted automatically and are applied for the selection of files and to check the consistency between products at different wavelengths.

After the processing of the measurements with the SCC, the analyzed data is submitted to the database and screened through the Quality Control (QC) procedures. Optical products corresponding to the same measurement (same station and same time, within 15 minutes of tolerance) are checked in a combined way.

The outcome of these quality controls is stored in the EARLINET database, and its details can be accessed by making a request to <u>earlinetdb@actris.imaa.cnr.it</u>. The optical products that are automatically uploaded will become level 2 if they pass all the basic quality controls (BQC), the advanced quality controls (AQC) and the multiproduct quality controls (MPQC).

4.1 PRODUCTS SELECTION FILTERS

A dataset may contain multiple files at the same wavelength that contain different information (i.e., two products at a 355 nm wavelength, one containing only extinction and another containing extinction and backscatter). Therefore, a filter is applied to decide which file contains the highest amount of information to select the file that needs to be uploaded into the EARLINET database.

The filters implemented are the following:

- For backscatter files (b-files), the filter is based on:
 - \circ the presence of the depolarization variable (volume and/or particle)
 - the Raman presence (the "backscatter_evaluation_method" variable value is "Raman elastic backscatter")
- For extinction files (e-files), the filter is based on:
 - Presence of the backscatter variable

Based on the presence or absence of these variables, the file selection will be made to make available on the database the maximum amount of information possible.



4.2 CROSS-WAVELENGTH MEASUREMENT QC CHECKS

4.2.1 Backscatter consistency QC

The first quality control is applied to the backscatter profiles, and it checks if backscatter profiles from different files (i.e., in the backscatter file and in the extinction file, where the backscatter is calculated at a coarser resolution) are consistent with each other. To do this, the backscatter at the higher resolution must be brought at the coarser resolution, which is done using the vertical resolution reported in the files. Then, the two products are considered consistent if the largest statistical errors of the two products do not differ more than 3 times the statistical error (3-sigma). This QC is considered successful if 90% of the points or more pass this test.

4.2.2 Lidar Ratio & Ångström exponent checks QCs

The next QC checks are based on the intensive properties, which come from the combination of products at different wavelengths. The intensive parameters that are checked are the lidar ratio and the Ångström exponent (extinction and backscatter related). The values of these parameters must be in a physical meaningful range ([0 – 200 sr] for lidar ratio and [-1 – 4] for Ångström exponent) in the altitude range where a not negligible quantity of aerosol is observed (this is checked through backscatter threshold value)*.

To calculate the intensive properties, the two products used must be at the same resolution. If needed, this is done, and then the lidar ratio and the Angstrom exponent are calculated to apply the QCs.

This QC is satisfied if:

- 90% of the points or more within the profile are within the physically meaningful range
- the statistical errors of the intensive properties are above 50%
- the value of the intensive parameters is within the meaningful range of values within 3 standard deviations.

* The values indicative of an aerosol layer presence is (in agreement with current quality control procedure applying to the ACTRIS/EARLINET database): 5 10^{-7} m⁻¹ sr⁻¹ for backscatter, and 2.5 10^{-5} m⁻¹ for extinction.

