

EARLINET Data Off Line Quality Check – v1.1

Summary

1- Introduction.....	2
2- Off-lineTechnical Quality Check v1.1.....	3
3- Off-Line Physical Quality Check v1.1	4

V1.1

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1- Introduction

Data quality check procedures for EARLINET/ACTRIS database improved over the time.

This document reports the automatic quality check procedures implemented off-line that are being applied systematically on the data on 3-months schedule since 14 June 2018, data on which the QC procedure was slightly modified respect to the previous 1.0 version operational since February 2017.

Respect to the Off Line QC 1.0, the following criteria were changed:

- None, only OnFly QC modified. See related documentation.

These checks are mostly related to physical content of the files and are intended to provide an information to the users about which are the data of assured quality for aerosol climatological study (data compliant to established physical quality checks) and which are instead data presenting peculiar or maybe suspicious values (data failing physical quality checks). The latter may require special attention in their use. On the other hand, the highlight of these latter cases could be a useful tool for identifying special study cases.

A feedback to the Data Originator is provided as output of the off-line quality check procedures. The information to the users about the data level in terms of quality check is provided through log file reported on the EARLINET webpage, listing all files reported into the database and for each level of quality: QC0.0 data compliant to QC procedure v0.0; QC1.0 data compliant to the Technical Quality Check v.1.0 but failing the Physical Quality Checks, and QC2.0 data compliant to the both Technical and Physical Quality Checks.

Details of the off-line systematic QC procedures are reported in the following sections.

2- Off-line Technical Quality Check v1.1

These technical quality checks complement the on-fly technical quality checks reported in *EARLINETQCon_fly_v1_1.pdf* with checks related to the right association to the different EARLINET data categories (<https://www.earlinet.org/index.php?id=125>).

TQC_06

The EARLINET climatological schedule established as routinely measurements the ones performed on Monday around noon and around sunset and on Thursday around sunset. The schedule was established for providing a climatological dataset with a fixed time during the week and simultaneous measurements around the network. Only measurements performed with this schedule can be considered as climatologic measurements.

A check with calendar is implemented: it checks if Climatology Measurements had been made on Monday and Thursday.

TQC_07

A check on cirrus presence is done. It checks that files associated to *cirrus category* reports some comments about the cirrus/ cloud.

— Check the presence of the keywords : cirrus, cloud in the cirrus category files.

TQC_08

A check on cirrus presence is done. If cirrus/clouds keywords are reported in the comments, files should be in cirrus category.

TQC_09

If a file is classified as cirrus, all the simultaneously co-located files must be classified as cirrus. A procedure for this check has been set up.

TQC_10

The CALIPSO EARLINET correlative measurements are considered overpasses if the relative distance is maximum 100 km (what within the network was called Case 1 or Case A). All the other CALIPSO related measurements are performed for variability studies and could accomplish the CALIPSO related investigation, but cannot be considered as “collocated” measurements. The CALIPSO category contains the measurements related to the centralized alerted CALIPSO overpasses (Case1-2-3 or Case A-B-C). For the alerted stations, the measurement is considered compliant with the distributed overpass table if the temporal distance between the overpass and the analysed data is less than 12 hours (maximum temporal distance considered for variability study in the ESA-CALIPSO project and Pappalardo et al., JGR 2010).

A check with distributed overpass tables is implemented for this.

3- Off-Line Physical Quality Check v1.1

PQC-00

This procedure scans each profile and check that the error on the optical properties are positive for all defined value of the corresponding optical property.

A file does not pass the PQC00

- * if at least for 1 error point is negative, zero or not defined, for defined optical property value

PQC_01

This procedure scans each profile and check that the aerosol optical properties are positive within 3sigma, that there are not negative peaks and that very extreme values are present only in cirrus cloud cases.

Check on backscatter :

- * backscatter plus a Threshold value ≥ 0
- * OR $\text{abs}(\text{backscatter}) < 3 \cdot \text{errBackscatter}$
- * $\text{backscatter} < \text{Back_peak}(\text{Wavelength})$ if it does not belong to cirrus category

Checks on extinction :

- * extinction plus a Threshold value ≥ 0
- * OR $\text{abs}(\text{extinction}) < 3 \cdot \text{errExtinction}$
- * $\text{extinction} < \text{Ext_peak}(\text{Wavelength})$ if it does not belong to cirrus category.

For a first screening of unrealistic negative peak value, a value representative of an aerosol layer is used. In particular $b_{\text{th}} = 5 \cdot 10^{-7} \text{ m}^{-1} \text{ sr}^{-1}$ and $a_{\text{th}} = 2.5 \cdot 10^{-5} \text{ m}^{-1}$. These threshold values are set as 50 times the calibration value for the 1064nm.Wavelength and IB are scaled in the most conservative way, and threshold are keep 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 $\text{ext} > 0.005 \text{ m}^{-1}$ is less than 5%. Correspondingly a $b_{\text{peak}} = 1.7 \cdot 10^{-4} \text{ m}^{-1} \text{ sr}^{-1}$ had set up assuming a lidar ratio of 30sr (most conservative value) has been assumed.

PQC_02

Integrated quantities of the aerosol properties should be positive and not exceed very extreme values not realistic for aerosol layer cases. 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.

$$\text{AOD} > 0$$

$$\text{AOD} < \text{AOD}_{\text{th}} \text{ if it does not belong to cirrus category}$$

The threshold values $\text{AOD}_{\text{th}} = 1.5$ 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 $\text{AOD} > 1.5$ 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.

PQC_03

As for AOD, integrated quantities of the aerosol backscatter should be positive and not exceed very extreme values not realistic for aerosol layer cases. 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.

$$\text{IB} > 0$$

$$\text{IB} < \text{IB}_{\text{th}} \text{ if it does not belong to cirrus category}$$

Starting from the AOD_{th} discussed above, the $\text{IB}_{\text{th}} = 0.05 \text{ sr}^{-1}$ 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.

PQC_04

This procedure checks the Lidar Ratio (S) values when Extinction and Backscatter are provided in the same file (i.e. are provided at the same vertical resolution). Lidar ratio is defined as positive value and values are typically between 10 and 120 sr. A wider window is defined for excluding not realistic values without constraining the pdf of the S values.

$$S \in [0; 200] \text{ sr within } 3\sigma_S$$

However, lidar ratio is an intensive property so it is defined only where aerosols are significantly present. So 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 treat as a minimum aerosol layer detection limit and with a limited statistical uncertainty. In particular, the following check is performed:

$$\text{If extinction} > \text{Ext_dect}(\text{Wavelength}) \text{ AND } (\text{errExtinction}/\text{extinction}) < 50\%$$

$$\text{AND If backscatter} > \text{Bck_dect}(\text{Wavelength}) \text{ AND } (\text{errBackscatter}/\text{backscatter}) < 50\%$$

* LidarRatio must be between [0 - 200] sr in $3 \cdot \text{ErrorLidarRatio}$

$\text{Bck}_{\text{dect}} = 5 \cdot 10^{-7} \text{ m}^{-1} \text{ sr}^{-1}$ and $\text{Ext}_{\text{dect}} = 2.5 \cdot 10^{-5} \text{ m}^{-1}$ and where the uncertainty on extinction and backscatter is lower than 50%.