ACTRiS
Centre for Aerosol Remote Sensing

Guidelines and recommendations for the candidate ACTRIS Aerosol Remote Sensing Observational Platforms

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APPLICABILITY OF THE DOCUMENT

These guidelines apply to the observational platforms which intend to become ACTRIS Aerosol Remote Sensing National Facilities.

ACRONYMS

ACTRIS- Aerosol, Clouds and Trace gases Research InfraStructure

NF - National Facility

CARS - Centre for Aerosol Remote Sensing

ARES – Aerosol Remote Sensing unit of the ACTRIS Data Centre

DC – Data Centre

SCC – Single Calculus Chain

RRT – Real-real time (less than 3 hours form the measurement)

NRT – Near-real time (less than 3 days from the measurements)

REFERENCE DOCUMENTS

Documentation on technical concepts and requirements for ACTRIS Observational Platforms

ACTRIS NF Labelling Plan

Descriptions of the workflows between ACTRIS components

ACTRIS Data Management Plan

CARS implementation plan

1. INTRODUCTION

An ACTRIS Aerosol Remote Sensing National Facility should operate an aerosol high-power lidar and an automatic sun/sky/lunar photometer. These instruments should be collocated, i.e. situated in the same mixed layer in order to measure the same atmosphere. The maximum allowed horizontal distance is 1 km.

The minimum setup of an ACTRIS aerosol remote-sensing station consists of a one-wavelength Raman with polarization discrimination capability and a sun/sky photometer. The lidar must be operated following the measurement schedule for climatological observations (**Section 3.1**) and shall in addition contribute to the observation of special events and satellite validation activities. The photometer has to be set up for automatic operation.

The optimum setup of an ACTRIS aerosol remote-sensing station consists of a three-wavelength Raman or high spectral resolution lidar with polarization discrimination capability and an automatic sun/sky and moon photometer (optionally also polarized) according to ACTRIS/AERONET standards, both operating continuously.

The instruments must fulfill the mandatory requirements described in **Section 2.1** and **Section 2.2** respectively. Standard Operation Procedures and Standard Quality Assurance Procedures issued by of the Centre for Aerosol Remote Sensing (CARS) must be applied. If available, calibration and quality assurance tools approved by CARS must be implemented at the National Facility and used according to guidelines and recommendations. Participation of the National Facility to QA/QC activities scheduled by CARS is mandatory. These include but are not limited to the QA/QC activities in **Section 4.1** and **Section 4.2** respectively**.** In addition, and if necessary, CARS may schedule direct comparisons, site audits, training sessions and/or other actions.

National Facilities have the responsibility to securely and permanently store and archive native data from the instruments and Level 0 data (raw data in the format to be submitted to the DC units). In order to guarantee secure store and archive of such data, the National Facilities should organize their archive in two different physical locations. Level 0 data must be uploaded automatically to the respective units of the DC (lidar) or TC (photometer) for processing in RRT or NRT. All higher-level ACTRIS variables will be produced and provided by the DC/TC units, including respective QA/QC. A list of variables is provided in **Annex 1**.

2. INSTRUMENTS

2.1. Specific requirements for the aerosol high-power lidar

Measurements of aerosol extinction, backscatter and depolarization-ratio profiles are to be performed at least at one wavelength, either 355 or 532 nm.

Technical system parameters such as laser power, telescope aperture, receiver bandwidth and data acquisition system must be chosen such that profiles can be acquired throughout the troposphere up to the lower stratosphere with the required accuracy and temporal and spatial resolution. A separate near-range receiving system is recommended for observations in the lower planetary boundary layer. Configurations may vary to account for climatic circumstances, e.g., the typical height of the boundary layer for the location of the NF.

Tab. 1 Summary of mandatory and recommended technical requirements

Parameter	**Mandatory (minimum requirements)**	**Recommended (optimum requirements)**
Channels	1β + 1α + 1δ at 355 nm or 1β + 1α + 1δ at 532 nm	1β + 1α + 1δ at 355 nm and 1β + 1α + 1δ at 532 nm and 1β at 1064 nm
Height resolution raw (recorded signal)	≤ 15 m	≤ 3.75 m
Time resolution raw (recorded signal)	≤ 60 s	≤ 10 s
Full overlap (m)	≤ 300[1]	≤ 200
Minimum altitude range of the 355 raw signal (to be obtained in **defined conditions**, see below)	≥ 15 km	
Minimum altitude range of the 532 raw signal (to be obtained in **defined conditions**, see below)	≥ 15 km	
Minimum altitude range of the 1064 raw signal (to be obtained in **defined conditions**, see below)	≥ 10 km	
Features	• Laser alignment (alignment camera[2]) • Polarisation calibration • Telecover • Dark signal measurement • Photodetector eye piece[3]	• Unattended operation • Automatic laser alignment • Automatic polarization calibration • Automatic telecover

[1] This value must be reached in max. 5 years form the initial acceptance, for at least one couple of elastic and Raman channels. The applicability of the overlap correction will be investigated.

[2] Only if the assembly of a camera is not possible, alternative "online" control mechanisms for the laser alignment can be approved after verification by CARS.

[3] Alternative methods to overcome the sensitivity inhomogeneity of the photodetectors can be approved after verification by CARS.

	• Pretrigger ≥20 µs	• Automatic dark signal measurement • Photodetector eye piece • Pretrigger ≥20 µs • Temperature and humidity control • Lidar status control • Eye safety (automatic shut-down)

Defined conditions for which the minimum altitude range of the raw signals must be obtained:
With clean air in the far range and an averaging time 1 hour:

- for 355 and 532 nm with aerosol OD 0.4 in the lower troposphere and a range resolution of 250 m, the SNR in the cross and parallel channels, respectively, must be:
  - 355 nm: SNR ≥17 (cross) and ≥65 (parallel) at 15 km;
  - 532 nm: SNR ≥11 (cross) and ≥55 (parallel) at 15 km;
- for 1064 nm with aerosol OD 0.13 in the lower troposphere and a range resolution of 500 m the SNR in the total signal must be: SNR ≥9 at 10 Km.

Things to consider when purchasing a new lidar

The fulfillment of the above requirements will be checked by CARS regularly through specific QA tests and, for the new or upgraded lidars, through direct comparison with a reference lidar. In order to make sure that the lidar will be compliant when delivered, CARS advises the buyers to include the following requirements in the tendering documents, in addition to the technical specifications:

1) Proof of experience

The tender should include proof of the successful production of previous systems which had similar capabilities to the specified system and are compliant with ACTRIS requirements (latest version of the "***Guidelines and recommendations for the candidate ACTRIS Aerosol Remote Sensing Observational Platforms***", available at: https://www.actris.eu/topical-centre/cars/announcements-resources/documents). The tender should also include references from two previous customers, preferably from other ACTRIS National Facilities.

2) System acceptance

The verification of the fulfilment of the specifications shall be carried out within the framework of a test plan to be coordinated by the Contractor with the Client in advance. Within the scope of this test plan, measurements of technical parameters shall be carried out by the Contractor and recorded. The acceptance will be divided into a Factory Acceptance Testing (FAT, at the Contractor site) and a Site Acceptance Testing (SAT, at the Client site).

The Contractor shall prepare corresponding test reports for FAT and SAT and make them available to the Client in due time. The test reports shall include the test data in the standard format defined by CARS.

The FAT procedure should contain continuous measurements (proved by quicklooks) during five consecutive days with QA tests (dark, telecover, Rayleigh-fit and polarisation calibration measurements) performed at every day and every night, and can be extended further up to a maximum of seven days in total, in case the environmental conditions are not favorable for the tests to be performed. The measurement data of the results of the FAT are to be handed over to the Client at least one month prior to the shipment. Within this timeframe, the Client may consult CARS for opinion. The Client will inform the Contractor about the acceptance not later than one month after the delivery of the FAT, and has the right to refuse the shipment in case the test results prove that the lidar is not compliant.

The SAT shall be carried out jointly by the Contractor and the Client during the installation on site and will last two days. A full set of QA tests has to be performed both at day and night, and immediately delivered to CARS for analysis. The Client has the right to refuse the deliverance in case the QA test results prove that the lidar is not compliant. The results are to be documented in a joint protocol.

Each QA-measurement set must comprise:

- Six consecutive five minute-averaged dark measurements of the analogue signals
- Telecover measurements with ten times NESW sector measurements of 30 second averages for each quadrant sector in order to decrease the influence of atmospheric changes.
- Rayleigh-fit measurements with one hour average with an aerosol-free region of at least 1 km range at a minimum height of eight km.
- Polarisation calibration with an uncertainty of the polarisation calibration factor of 2% or less.
- Camera images of the laser beam alignment

3) Relevant Standards and accreditations

The supplier shall maintain a Quality Management System in accordance with DIN EN ISO 9001.

4) Training

Training for up to four people will be provided at Lidar Installation site when the instrument is installed.

5) Force Majeure Event and hardship

Force Majeure shall be limited to one or more of the following events: hurricanes, tempest, acts of state or public enemy, wars, revolutions, uprisings, hostilities, civil disturbances, riots, civil war, pandemic like COVID-19, insurrection, and invasion. For the avoidance of doubt, strikes, lockouts and shutdowns of a Party (or of any person engaged by any of them) shall not be a force majeure event for that Party. Hardship Clause 2020 also applies.

6) User and Service Manuals

Electronic copies of full manuals for setup, operation, maintenance and software are required to be delivered latest with the delivery of the FAT.

Full specifications (paper or electronic) for all components, including optics, are required. These should include (besides the common lidar specifications):

- Laser beam divergence (full width) at the circle which includes 86% of the energy

- Trigger delays for analogue and photon-counting signals for all channels
- Dead time for all photon counting channels
- Telescope diameter, focal length and secondary mirror obscuration
- For each interference filter: interference filter centre wavelength, full-width-half-maximum bandwidth, full-width bandwidth at 90% of maximum, effective refractive index and out-of-band blocking (optical density and range over which that optical density applies)
- Manufacturer and type of the detectors with specifications from the manufacturer
- Nominal high voltage of the detectors (PMTs or APDs).
- Diattenuation of the receiver and transmitter optics with polarisation effects at the used wavelengths
- Degree of linear polarisation of the emitted laser beam at all wavelengths at which polarization measurements are performed.
- Rotation angle of the plane of the major axis of the laser polarisation (beta) with respect to the reference plane of the receiver optics, for which usually the incidence plane of the polarising beam splitter cube is used, at all wavelengths at which polarization measurements are performed
- Ellipticity of the laser polarisation (or the degree of circular polarisation).
- The measured expansion and polarization properties of the beam expanders
- Di-attenuation measurements for all the relevant optical components
- Optical ray-tracing of all the optical paths
- Dead time measurements for all the optical channels
- Laser polarization purity measurements for the transmitted beam at all wavelengths at which polarization measurements are performed, with details of measurement technique

Note: In case the lidar is provided in a container, the container must be IP66-rated, and the mechanical design drawings of the container layout must be provided. Lightning protection must be provided.

7) Warranty

Warranty of parts against partial or full failure for 2 years should be included, except for the laser and its components where 1 year is required. All components used must be brand new.

8) Service and spare parts

The instrument should be supplied with one set of spare flashlamps and a spare laser deioniser cartridge and water filter (if used). The cost of routine spare parts for future use should be detailed in the tender.

Prompt support and repair service must be committed by the Contractor, especially on-site support when repairs are required for which shipping of components to the supplier is impractical, or when repair or re-installation requires high skill levels or equipment knowledge, and free telephone and e-mail support during office hours. The tender should describe the services and conditions that are provided by the manufacturer.

9) Milestones (possibly related to payments)

- Delivery of the system design
- Delivery of the detailed specifications of the system (Handbook of Instrument)

- Delivery and acceptance of the FAT report
- Delivery of the system and provision of training
- Delivery and acceptance of the SAT report

2.2. Specific requirements for the automatic sun/sky/lunar photometer

Instrument observation capability

For columnar aerosol measurements, the required instrument is a fully automatic sun/sky photometer including the direct-moon extinction measurement capability.

Spectral AOD (day and night) and downward angular atmospheric radiance measurements (also called sky radiance) are mandatory. In addition, sky angular polarization measurements can provide the full picture of the radiation characteristics, but remain optional. Direct sun/moon and sky radiance measurements follow a consistent scheduled scenario.

Two versions of automatic sun/sky/lunar photometers can be considered,

- Cimel 318T Standard model, basically equipped with the 9 the following spectral filters (CWL/BW: 340/2, 380/4, 440/10, 500/10, 675/10, 870/10, 937/10, 1020/10, 1640/25 nm)
- Cimel 318P Polarized model, performing additional sky polarization measurements at the same wavelength as the standard model. It should be noted that this instrument performed much more measurements which take more time and need more energy.

Instrument setup conditions

Clear field of view with a maximum 10° elevation mask in all the directions is requested. South ways not obstructed.

Data transfer and communications

It is mandatory that the data are transferred regularly (no more than 1h after acquisition) to the ASP/AERONET units in charge of Quality Control and Assurance. For this purpose, several transmission channels may be used like RS232 (with USB adaptor) to connect to computer (100 m line max), USB for local and temporary connection to a laptop, GPRS to transfer data to the network FTP with Sim Card, Satellite to transfer to the database via a transmitter to a geostationary satellite from EUMETSAT for example.

Data is typically transmitted via 2 channels. For a majority of sites, data is transmitted by either the software provided with the instrument or software developed by ASP/AERONET units running on a PC linked to the internet and to the photometer. In case of a very remote site far from the internet, a satellite transmitter is used, over Europe and Africa, through EUMETSAT channels. Date rate is however low which has impacts on the photometer polar and lunar versions having a too high data rate for this type of transmission).

Instrumental limitations and duty cycle

The instrument belonging to the user must benefit from recent technology progress and should not be older than 15 years.

To preserve observation continuity at his site during the calibration phase that may require about 2 months, an additional photometer head is necessary since the ASP/AERONET units cannot guarantee available spare instruments. ASP/AERONET units consider this as an investment to be done at the country level (mutualization of spare instruments).

3. OPERATION

It is recommended to operate both instruments continuously, weather permitting.

3.1. Operation of the aerosol high-power lidar

ACTRIS high-power aerosol lidars should be preferably operated continuously, in the absence of precipitation or fog. The instrument should be operated as described in the "***Standard Operation Procedure for aerosol high-power lidars***". For data submission to SCC please see **Section 5.1**.

If the instrument is not automated, it must at least provide unbiased long-term regular observations following the **pre-defined schedule with 5 observations per week, each with a duration of minimum 3 hours:**

Tab. 2 Minimum schedule of measurements to be performed, weather permitting:

No.	Day of the week	Time of the day
1.	Monday	11:30 -14:30 LT[4]
2.	Monday	18:30 - 23:30 UT
3.	Wednesday	11:30 - 14:30 LT[4]
4.	Thursday	18:30 - 23:30 UT
5.	Friday	18:30 - 23:30 UT

In order to allow comprehensive climatology, Saturday daytime measurements are recommended but not mandatory.

Furthermore, measurements are to be performed upon alert, e.g., in hazardous situations such as volcanic eruptions, for special events such as dust outbreaks or forest fires, and for dedicated satellite validation purposes. Satellite validation measurements will follow a specific strategy. Alerts and measurement schedules for collocated observations during satellite overpasses will be distributed by the ARES unit of the ACTRIS Data Centre.

3.2. Operation of the automatic sun/sky/lunar photometer

Standard observation protocol

Photometers are fully automatic and follow standard measurement protocols defined by infrastructure or network. They must be always in the situation to operate as soon as the precipitation ends. For aerosol observation, several observation scenarios are scheduled day and night. Spectral AOD measurements are performed quite frequently when cloud cover permits. Sky radiance angular exploration is performed much less frequently and in at least four spectral bands (440, 675, 870 and

[4] The daytime measurement schedule will be updated in order to optimize GARRLIC retrievals.

1020 nm) within different geometries (almucantar, principal plane, hybrid). For standard measurement scenario, larger solar zenith angles are preferred since this situation allows larger scattering angle which is suitable to reach QA level for inversion products.

Cloud Mode option

Cloud optical thickness, for even broken clouds, from surface measurements of zenith radiance in the visible and near-IR spectral regions can be retrieved if cloud-mode is activated. Contact ASP/AERONET or website for configuration.

Extreme weather situation

In extreme weather conditions (hurricane, strong blizzard, big storm) it is preferable to stop the instrument or to remove the head sensor. If the average temperature is low (lower than -10°C, polar region), it is recommended to heat the robot. If the temperature is <-20°C it is imperative to heat the instrument and to use specific batteries. For positive temperatures, we recommend using a dedicated optical sensor to detect rain, snow and blizzard to stop the system.

Condition for photometer-Lidar synergy

Standard joint retrieval combining photometer data and lidar range corrected data requires coincident acquisition and especially in the morning and evening (when solar zenith angle > 50°) meaning scattering angle can reach high value which is suitable for inversion (AERONET and ACTRIS) and QA. Moreover, it is mandatory that lidar and photometer are co-located (with a tolerance of maximum 1 km) to prevent disturbances in the joint retrievals due to atmospheric inhomogeneities.

4. QUALITY ASSURANCE

4.1. Quality Assurance of the aerosol high-power lidar measurements

QA/QC of the Level 0 data

Quality control of the aerosol high-power lidar Level 0 data is in the responsibility of the instrument operator, with the support of CARS. ACTRIS high-power aerosol lidars should apply specific calibration and quality assurance measures and tools. Quality assurance measures for aerosol lidars include internal and external check-ups.

External check-ups refer to:

1. **Direct comparison with a reference lidar systems operated by CARS**. Intercomparison measurements with one of the reference lidar systems shall be performed for new systems and after major upgrades.
2. **Analysis of the QA tests by CARS**. The QA tests will be analyzed regularly by CARS experts in order to check and approve the instrument configuration in the Single Calculus Chain (SCC). QA tests to be performed by the operator and reported to CARS are:

Tab. 3 Mandatory Quality Assurance tests to be submitted to CARS:

QA test	Purpose	Periodicity for reporting
Telecover	test optical alignment	2 times / year
Rayleigh fit	test optical alignment	2 times / year
Polarization calibration	calibration	each time the lidar changes
Zero bin test	electronic synchronization	one-time test, after major upgrades
Dark signal measurement	electronic distortion subtraction	each time the lidar changes

3. **Site audits**. Site audits will be scheduled and performed by CARS for new National Facilities and/or in case of persistent instrumental problems.

Internal check-ups refer to:

1. **Regular performance of the QA tests**. Operators are advised to perform the QA tests (see Tab. 3) as often as possible, and check the instrument's performance over time.
2. **Implementation and use of the QA/QC tools approved by CARS**. Specific tools developed by CARS can be downloaded from CARS website. These tools have to be applied regularly based on the recommendations and under the supervision of CARS.

Details are described in the "***Standard Quality Assurance Procedures for aerosol high-power lidar*".**

QA/QC of the Level 1, 2 and 3 data

Quality assurance and quality control of the higher-level data products (Level 1 to Level 3) are in the shared responsibility of ARES which operates the centralized data processing system (Single Calculus Chain), and the PI.

4.2. Quality Assurance of the automatic sun/sky/lunar photometer

ASP units are in charge of most of the quality control/assurance activities, by regularly following instrument status, detecting anomalies, informing users and solving problems. However, there are mandatory / recommended procedures to be followed by users.

Data Quality Monitoring Tools

All NF operators have free access to the monitoring webpage and can remotely check the status of their instrument (battery level, tracking system, humidity and temperature sensors, etc.). Users/Operators also have easy access to data in near real time, so that they can detect apparent calibration shifts due to collimator obstruction or similar issues.

Weekly Check procedures

The users and operators of NF are involved in the quality control process. The visual inspection of the instrument (optics, collimator and cables to solar panel and data transmission system) once a week is required. If users/operators are not following these protocols, data quantity and quality could be dramatically affected and quality assurance procedures will not allow the data to reach the QA assured data level in the database.

NF-CF interactions

To maximize the duty cycle of the instrument, users/operators are expected to be reactive on alerts sent by the CF corresponding units.

Calibration

Regular recalibration is mandatory and expected to be performed every 12 months on average. After the calibration, it is required to set the instrument up again as quickly as possible. To preserve observation continuity at his site during the calibration phase that may require a couple of months, an additional photometer head is necessary since the ASP/AERONET units cannot guarantee available spare instruments. ASP/AERONET units consider this as an investment to be done at the country level (mutualization of spare instruments).

5. DATA PROVISION

5.1. Provision of the aerosol high-power lidar to the ACTRIS Data Centre

In order to be labelled as ACTRIS data, aerosol high-power lidar raw data acquired at NFs are **mandatorily processed at the ACTRIS DC using the Single Calculus Chain (SCC).** The NF is responsible for reporting and updating in the SCC the technical information about the instrument, and setting the appropriate SCC configurations to process the data.

Two kinds of SCC configurations can be used:

- **Operational configurations** are set by the NF and are approved by CARS and ARES based on the analysis of the regular QA tests. Level 2 and 3 products can only be obtained if approved operational configurations are used. The list of parameters to be included in the SCC operational configuration is available in **Annex 2.**
- **Experimental configurations** can also be set by the NF, without requiring the approval of CARS and ARES. All datasets processed with such experimental configurations are Level 1 data products.

For operational data products, Level 0 data (raw lidar data in the SCC input format) should be submitted in RRT or NRT to the SCC, but with a maximum delay of 1 day from the moment of the measurement. Higher-level data products should be pulled from the SCC, quality checked and further submitted to the ACTRIS DC. The quality control performed at ACTRIS DC provides feedback to the data originator, which can be useful for identifying potential problems of the instrument and fixing them at NF level or with the help of the Centre for Aerosol Remote Sensing.

5.2. Provision of the automatic sun/sky/lunar photometer to the ACTRIS Data Centre

For standard instruments, the raw data are transferred in NRT (< 1h) to one of the three dedicated databases in France, in Spain for European users (in the USA for other users). All three databases are synchronized. The NRT transfer to the database is mandatory to monitor the instrument and to perform NRT processing and product delivery. Tools are distributed to each user to allow NRT transmission through different channels (internet, satellite transmission for very special and remote places).

ANNEX 1 LIST OF AEROSOL REMOTE SENSING VARIABLES

Variable	Data product level	Requirement	Aerosol high-power lidar	Sun/sky/lunar photometer
Attenuated backscatter profile	L1, L2	Minimum		
Volume depolarization profile	L1, L2	Minimum		
Particle backscatter coefficient profile	L1, L2	Minimum		
Particle extinction coefficient profile	L1, L2	Minimum		
Lidar ratio profile	L1, L2	Minimum		
Ångström exponent profile	L1, L2	Optimum		
Backscatter-related Ångström exponent profile	L1, L2	Optimum		
Particle depolarization ratio profile	L1, L2	Minimum		
Particle layer geometrical properties (height and thickness)	L1, L2	Minimum		
Particle layer optical properties (extinction, backscatter, lidar ratio, Ångström exponent, depolarization ratio, optical depth)	L1, L2	Minimum		
Column integrated extinction	L1, L2	Minimum		
Planetary boundary layer height	L1, L2	Optimum		
Spectral Downward Sky Radiances	L1	Minimum		
Direct Sun/Moon Extinction Aerosol Optical Depth (column)	L1	Minimum		
Aerosol columnar properties	L2	Minimum		
Aerosol profile microphysical and optical properties	L2	Minimum		

ANNEX 2 LIST OF INPUT PARAMETERS FOR THE SCC OPERATIONAL CONFIGURATIONS

The following table includes:

- Blue rows = Parameters which **have to be set by the PI** in the operational configuration. For some of them, check by CARS/ARES is performed before approving the configuration (based on QA tests or other documentation)
- Green rows = Parameters which **are fixed** in the operational configuration. For some of them, the PI can ask for justified changes. Approval of CARS/ARES is needed.

No.	Parameter	Description	Apply to	Type of value	Value	Source of info / Applicable test	Approval / check by
1	Emission wavelength	Wavelengths of all the transmitted laser beams	all the laser wavelengths	Settable	Number	Datasheets (manufacturer)	-
2	Detection wavelength	Wavelengths at which each lidar channel is detected (usually the interference filter center)	all channels	Settable	Number	Datasheets (manufacturer)	-
3	Detection bandwidth	Bandwidth used to detect each lidar channels (usually interference filter FWHM)	all channels	Settable	Number	Datasheets (manufacturer)	-
4	Range resolution	Raw signal range resolution	all channels	Settable	Number	Datasheets (manufacturer)	-
5	Dead time	Dead time value corresponding to the whole PC acquisition system (PMT+discriminator+TR)	all PC channels	Settable	Number	Datasheets (manufacturer) / Hardware test if possible	CARS

No.	Parameter	Description	Apply to	Type of value	Value	Source of info / Applicable test	Approval / check by
6	Trigger delay	Electronic delay (positive value) of the acquisition system with respect to the laser pulse generation time	all channels	Settable	Number	Zero bin test	CARS
7	First signal rangebin	Rangebin corresponding to signal backscattered at zero altitude above lidar system level	all channels	Settable	Number	Zero bin test	CARS
8	Background subtraction mode	Method used for the atmospheric background calculation. Far field: average in the signal far field region; Pre-trigger: average in signal pre-trigger region	all channels	Fixed	Pre-trigger: average in signal pre-trigger region	-	-
9	Maximum acceptable count rate	Maximum count rate for the whole PC chain allowing reliable linearity between counts and actual light impacting on PMT.	all PC channels	Fixed	Default: 20 MHz	**PI notification**: gluing test, if different from the default value	ARES
10	Minimum acceptable signal level	Minimum reliable detection level for the whole analog acquisition system. Below this limit the signal is assumed to be dominated by distortions.	all analog channels	Fixed	Default: full_scale_mV/5000	**PI notification**: Rayleigh fit, if different from the default value	CARS

No.	Parameter	Description	Apply to	Type of value	Value	Source of info / Applicable test	Approval / check by
11	Polarization cross-talk parameters (G and H)	G and H parameters according to Volker's theory	all polarization sensitive channels	Settable	Number	Optical calculation	CARS
12	Correction factor for polarization calibration (K)	K parameter according to Volker's theory	all polarization sensitive channels	Settable	Number	Optical calculation	CARS
13	Handling of G, H, K parameters	Specify how G, H and K should be handled in case multiple values are available (average, take the closest in time to the measurements, take the latest....)	all polarization sensitive channels	Fixed	Take the closest in time before the measurement	-	-
14	Maximum statistical error below 2km	Maximum statistical error below 2km for each SCC products. Vertical resolution and time integration of each SCC product is fixed to meet this condition.	all SCC products	Fixed	Default: 50%	**Scientific objectives**, if different from the default value	ARES & CARS
15	Maximum statistical error above 2km	Maximum statistical error above 2km for each SCC products. Vertical resolution and time integration of each SCC product is fixed to meet this condition.	all SCC products	Fixed	Default: 50%	**Scientific objectives**, if different from the default value	ARES & CARS

No.	Parameter	Description	Apply to	Type of value	Value	Source of info / Applicable test	Approval / check by
16	Product detection limit	Detection limit of each SCC products. The value should provide the minimum observable value for each SCC product.	all SCC products	Fixed	Default: 5E-6 for extinction 1E-7 for backscatter	**PI notification**, if different from the default value	ARES
17	Minimum product height	Minimum height for the calculation of each SCC products. This value should be set to the full overlap height (if no overlap correction or signal ratio is applied)	all SCC products	Settable	Number	Telecover[5]	CARS
18	Maximum product height	Maximum height for the calculation of each SCC products. This value should be set to the height at which the lidar signal starts to be dominated by distortions, or at the uppermost height where strong aerosol layers (Cirrus or stratospheric layers can be measured in optimum conditions)	all SCC products	Fixed	Default: 20 km	**PI notification**: Rayleigh fit, if different from the default value	CARS

[5] The telecover analysis to include ratios of the signals in the future, in order to optimize this parameter for products which are calculated from the ratios of the signals

No.	Parameter	Description	Apply to	Type of value	Value	Source of info / Applicable test	Approval / check by
19	Preprocessing integration time	Time integration to consider in the pre-processing phase	all the low resolution SCC products	Fixed	Default: 30 min	**Scientific objectives**, if different from the default value	ARES & CARS
20	Preprocessing vertical resolution	Vertical resolution at which interpolate pre-processed signal	all the low resolution SCC products	Fixed	Default: 15 m	**Scientific objectives**, if different from the default value	ARES & CARS
21	Error calculation method	Method used to compute statistical error on each SCC products	all SCC products	Fixed	**Error propagation** for extinction & Raman backscatter, and vol. depolarization **Monte Carlo** for elastic backscatter	-	-
22	Monte Carlo iterations	Number of iterations to consider for the statistical error estimation using Monte Carlo simulations	all the SCC products for which Monte Carlo simulations are used to compute statistical uncertainties	Fixed	30	-	-
23	Extinction method	Method to use for the extinction retrieval	all extinction related SCC products	Fixed	Weighted linear fit	-	-
24	Particle Angstrom exponent	Value of particle Angstrom exponent to use in the extinction retrieval	all extinction related SCC products	Settable	Number	Site characteristics (climatological values from the photometer measurements)	ARES

No.	Parameter	Description	Apply to	Type of value	Value	Source of info / Applicable test	Approval / check by
25	Elastic backscatter method	Method to use for the elastic backscatter retrieval	all Raman backscatter related SCC products	Fixed	Fernald-Klett[6]	-	ARES
26	Fixed lidar ratio value	The fixed value of lidar ratio to use in the elastic backscatter retrieval.	all elastic backscatter related SCC products	Settable	Number	Site characteristics (climatological values from past Raman measurements)	ARES
27	Error on lidar ratio value	The uncertainty on fixed value of lidar ratio to use in the elastic backscatter retrieval.	all elastic backscatter related SCC products	Settable	Number	Site characteristics (climatological values from past Raman measurements)	ARES
29	Backscatter calibration options	Options to use for the calibration of Raman/elastic backscatter. These options specify parameters like the method, the minimum and maximum heights, the width of sliding window and reference backscatter value to use in the Raman backscatter calibration.	all backscatter related SCC products	Fixed	Default: 3-12 km, windows width: 500 m, Reference backscatter ratio: 1.0	**PI notification**, if different from the default value	ARES

[6] Automatic switch from Fernald-Klett to iterative to be implemented, in order to optimize the retrieval

No.	Parameter	Description	Apply to	Type of value	Value	Source of info / Applicable test	Approval / check by
30	Minimum Backscatter ratio for PLDR	Minimum backscatter ratio to consider in the calculation of particle linear depolarization ratio.	all depolarization SCC products	Fixed	Default: 1.1	**PI notification**, if different from the default value	ARES

ANNEX 3 SIMPLIFIED WORKFLOW OF THE AEROSOL REMOTE SENSING OPERATIONAL DATA

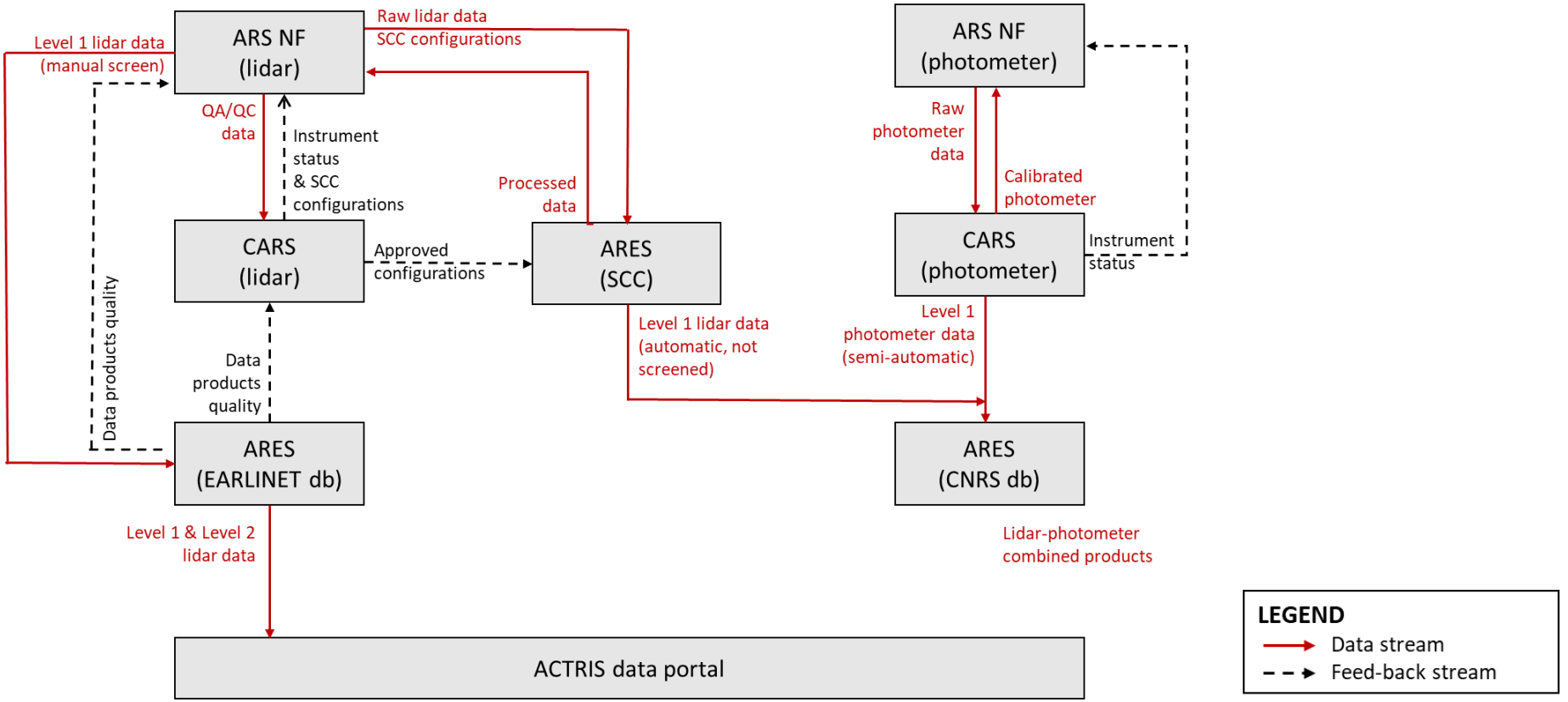

Fig. 1 Current workflow (simplified)

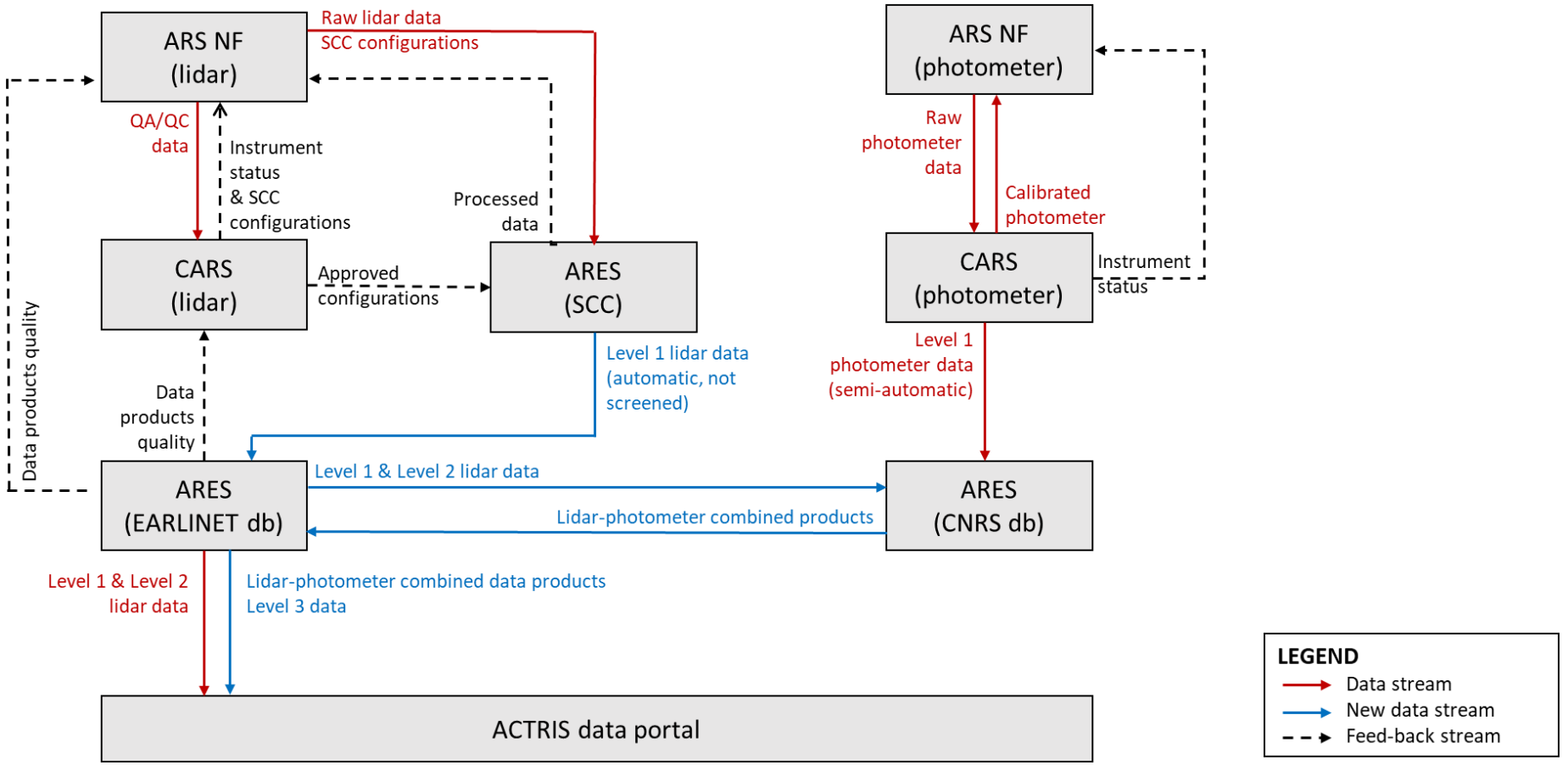

Fig. 2 Future workflow (simplified)