



First Annual report on aerosol profiling data provision

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Date: 31/01/2025

Ref: CAMS2_21b_2023SC1_D21b_1.3.1_202501_ First Annual report on aerosol profiling data provision

Official reference number service contract: 2023/CAMS2_21b_CNR - IMAA/SC1



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Change Log

Version	Date	Description



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Introduction

Building on the heritage of ACTRIS data workflow and previous CAMS 21b contract, the current contract named ACTRIS-APP consists in the provision of aerosol profiling data collected at 11 ACTRIS/EARLINET stations, aiming to the NRT and fully quality controlled data provision.

To fasten the data provision from the station to CAMS, automatic and machine-to-machine tools have been implemented. Typically, the submission from stations to ARES (Aerosol REmote Sensing) ACTRIS DC unit has been managed by the stations. Within this project, the automatic submission from the centralized processing suite of ARES to the ARES database has been made possible as a choice for the stations. A REST-API has been developed on top of the ACTRIS/EARLINET database to guarantee CAMS access to all produced data through a machine-to-machine connection. The REST-API offers the possibility to access all the ACTRIS/EARLINET data and it is not limited only to the stations involved within CAMS21b2 contract.

The current deliverable after a first section describing the data collection object of the CAMS21b2 contract, reports statistics on data products provided by ARES through the REST-API system for the first year of contract. Firstly, overall statistics for products are provided considering all the stations together. A further session analyses the provision station by station discussing specific issues and features. Finally, a conclusion session closes the deliverable.



1. CAMS21b_2 overall provision

The CAMS21b_2 data provision is related to measurements performed by the ACTRIS/EARLINET lidar stations reported in Figure 1 with the following time schedule, established with the investigation reported in CAMS21b contract (Mona et al., CAMS21b, 2020):

- Monday daytime (11:30 - 14:30 LT)
- Monday nighttime (18:30 - 23:30 UT)
- Wednesday daytime (11:30 - 14:30 LT)
- Thursday nighttime (18:30 - 23:30 UT)
- Friday nighttime (18:30 - 23:30 UT)
- Saturday daytime (11:30 - 14:30 LT)

The schedule, however, is limited to cases for which weather conditions allowed the measurements (no precipitation, no low clouds, and no fog).

Whenever meteorological conditions allow the measurements, the lidar stations perform 3 hours of measurements, providing for the aerosol optical properties three 1-hour profiles, which allows for temporal variability investigation.

Anyhow independently from such measurements schedule and CAMS21b_2 stations, all measurements collected by all the ACTRIS/EARLINET stations are openly provided through a REST-API interface (<https://data.earlinet.org/api/swagger-ui/#>).

The main aim of CAMS21b_2 contract is the provision of aerosol optical properties profiles to CAMS: in particular, aerosol backscatter coefficient profiles at different wavelengths (namely at 355, 532 and 1064 nm) and linear particle depolarization ratio profiles at 532 nm are provided. Additionally, in nighttime conditions, also the aerosol extinction profiles at 355 and 532 nm are provided. Besides these quantities, some intermediary products (like pre-processed signals at low and high resolution) are also provided for fully traceability.

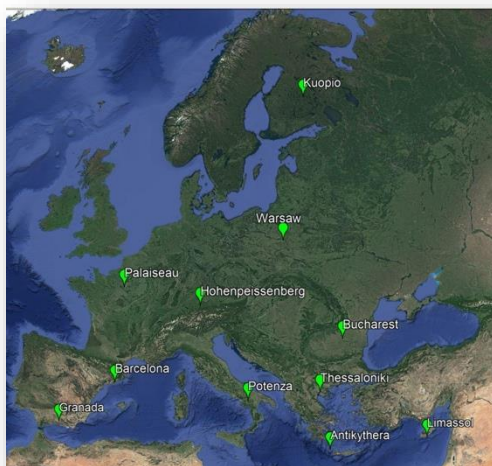


Figure 1 – ACTRIS/EARLINET stations involved in the CAMS21b2 provision.



In this contract, CAMS21b2, actions have been taken for providing the best possible quality of data already in NRT: the same level of QA/QC procedures applied for delayed data provision are now applied for the NRT provision. In addition, in case of automatic data submission multi-wavelength products are checked for consistency among the different retrieved optical products. All this in NRT.

Compared to the previous contract (CAMS21b), a big change has been implemented: data provided in NRT now goes through the ACTRIS/EARLINET DB, which guarantees versioning and traceability instead of relying on the processing suite (namely SCC). This also facilitates the users, who now have a unique file format and nomenclature to deal with.

The ACTRIS/EARLINET product types provided are summarized in Table 1: this includes the pre-processed data needed for obtaining geophysical products (processed products). Then, from the optical properties profiles additional quantities can be retrieved, such as the aerosol layers and the aerosol types.

Following the ACTRIS definition of data levels, Level 1 products are compliant with basic quality control procedures and Level 2 data are geophysical products approved and fully quality controlled. Therefore, only processed data are eligible to become Level 2 data products. At the time being only optical profiles provided by ELDA are eligible for the Level 2 label, since the other processed products are still experimental (reported in grey in the table).

Table 1 - ACTRIS/EARLINET products provided to CAMS. * indicates module working on post processing server and not in the SCC main core. Experimental products are reported in grey.

Product Type	Content	SCC module
Un-calibrated low resolution Pre-processed	Range corrected signals	ELPP
Un-calibrated high resolution Pre-processed	Range corrected signals Volume depolarization ratio	HiRELPP
Cloud mask Pre-processed	Cloud mask	CloudMask
Low resolution pre-processed	Total attenuated backscatter	ELIC
High resolution Pre-processed	Total attenuated backscatter Volume depolarization ratio	ELIC
Optical Processed	Aerosol extinction Aerosol backscatter Volume depolarization ratio Particle depolarization ratio	ELDA
Multiwavelength Optical Products Processed	Aerosol extinction Aerosol backscatter volume depolarization ratio particle depolarization ratio Lidar ratio Ångström exponent	ELDAmwI
Aerosol Layer -		LTool



Processed		
High resolution aerosol classification	Aerosol mask classification	HIRAC*
Preprocessed		
Low resolution aerosol typing	Aerosol type for each layer	MAC*
Processed		

2. CAMS21b_2 first year overall provision

Figure 2 reports the data provided in the whole 2024 by all the ACTRIS/EARLINET stations divided into data product category.

Overall, more than 35 k files have been provided by ARES in 2024. In particular, it is clearly visible the increase in the number of provided data after the starting of the CAMS21b_2 provision in February. Only April 2024 shows an anomaly with a smaller number of data provided respect to all the months in the March-December 2024 period, probably due to some stop in measurements at the stations for fixing small issues at stations side for improving the CAMS provision.

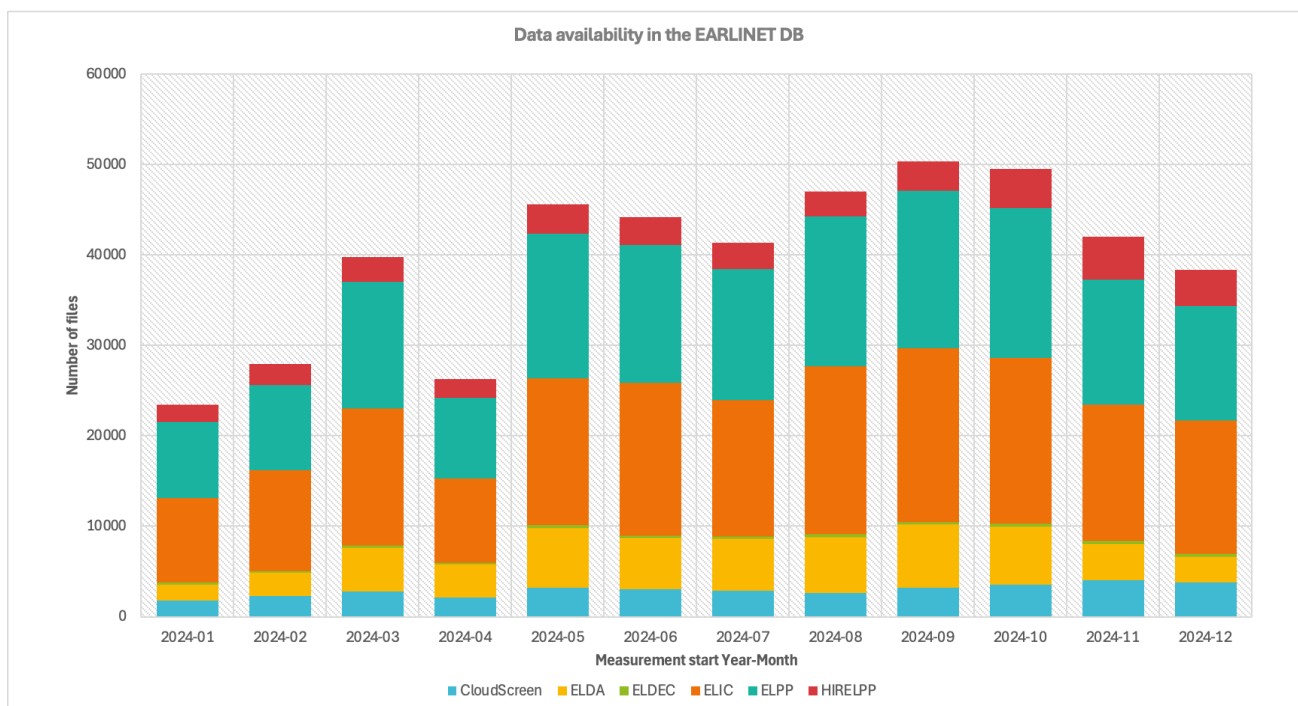


Figure 2 - data provided by all the ACTRIS/EARLINET stations in the 2024.

A significant difference is evident when the stations are categorized as participating (11 stations reported in Fig. 1) or not (the other 23 stations) to the CAMS21b_2 provision (Fig. 3). On average in 2024 CAMS21b_2 stations provided 1.7 times the number of optical products provided by the other



stations. The difference in the provision is particularly significant in Spring-Autumn period when the atmospheric conditions are typically unstable and the participation into CAMS21_b clearly motivated the CAMS21b_2 stations to do anyhow the measurements allowing the collection of optical products.

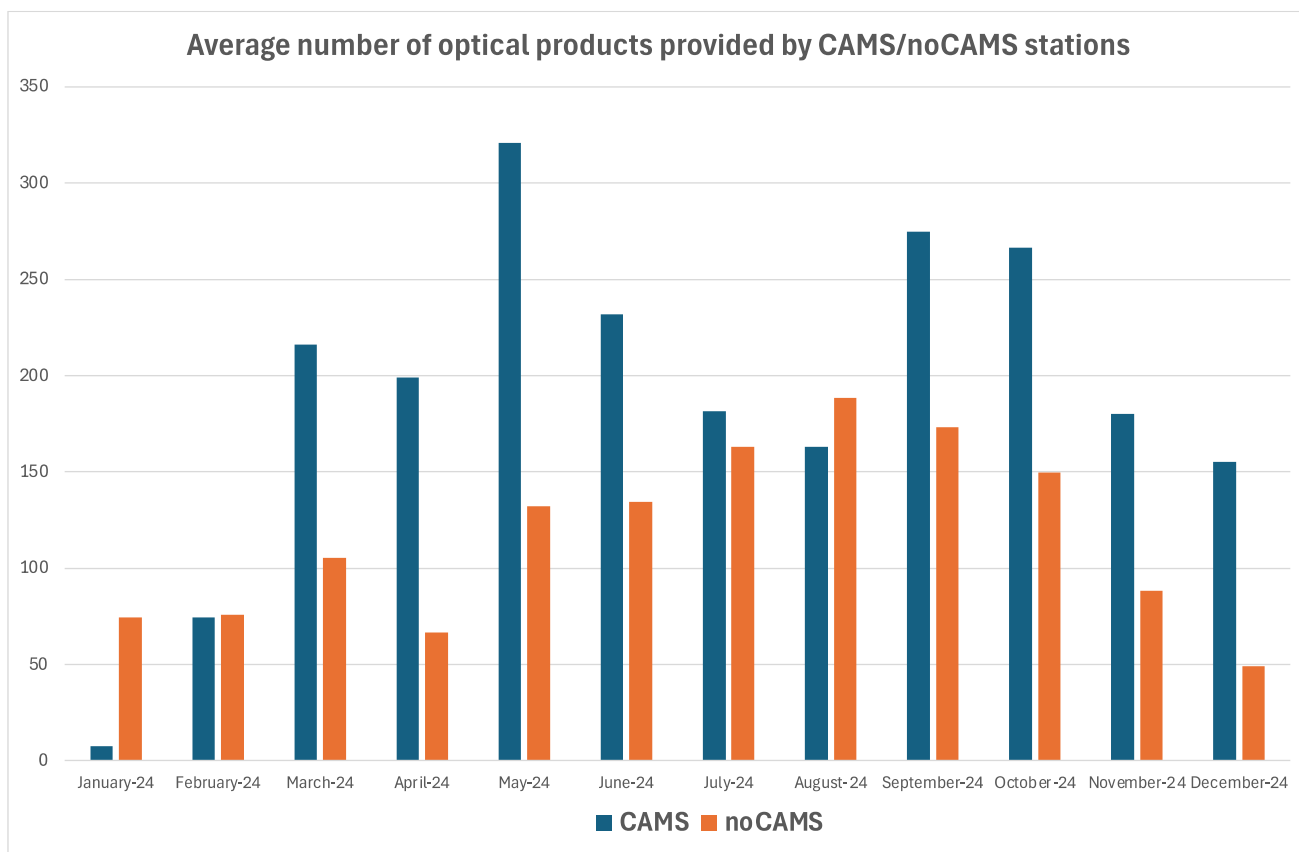


Figure 3 – optical product provided by CAMS/no CAMS stations in 2024

Finally Figure 4 reports the number of optical products provided by month and classified as Level 2 (fully quality controlled) and Level 1 (partially compliant to all the QC procedures) data. The low number of Level 2 data is due typically to the missing of lidar configuration qualify. The operational procedure for getting a lidar configuration qualified has been widely discussed in Q1 and Q2 of 2024 and first qualification of systems were implemented in July 2024 when the first Level 2 data came into the ACTRIS/EARLINET database. Reprocessing of old data accordingly to the status of new qualified configurations will be done in 2025.

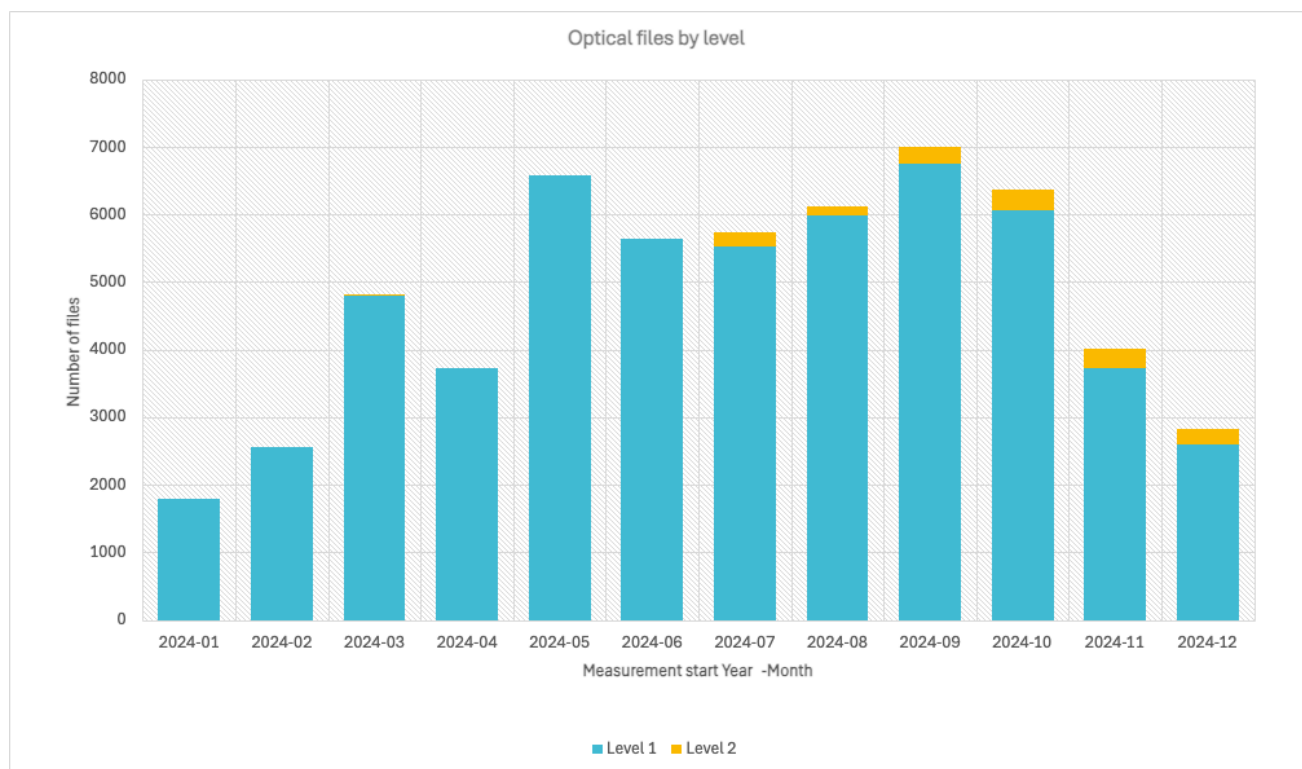


Figure 4 – number of optical files provide and classified as Leve 1 and Leve 2

3. CAMS21b_2 first year individual station provision

In the following, the provision of the different product categories and the NRT provision from each one of the stations is reported.

It is worth notice that Palaiseau, France - SIR is not reported and analysed here because indeed they are not yet providing data on the database, after encountering internal problems at their side first in doing measurements and then in setting up the automatic data workflow. SIR data are expected to come into the system in Q1-2025.

3.1 Antikythera, Greece - AKY

Antikythera station is currently uploading file in a manual mode. This means that data are sent to the ARES data centre manual (as highlighted by the high percentage, around 35%, of data uploaded not in NRT. The high number (around 20%) of the ELDA (optical products) files out of the total also underlines that the atmospheric conditions typically allow optical properties successful retrieval (Fig. 5).

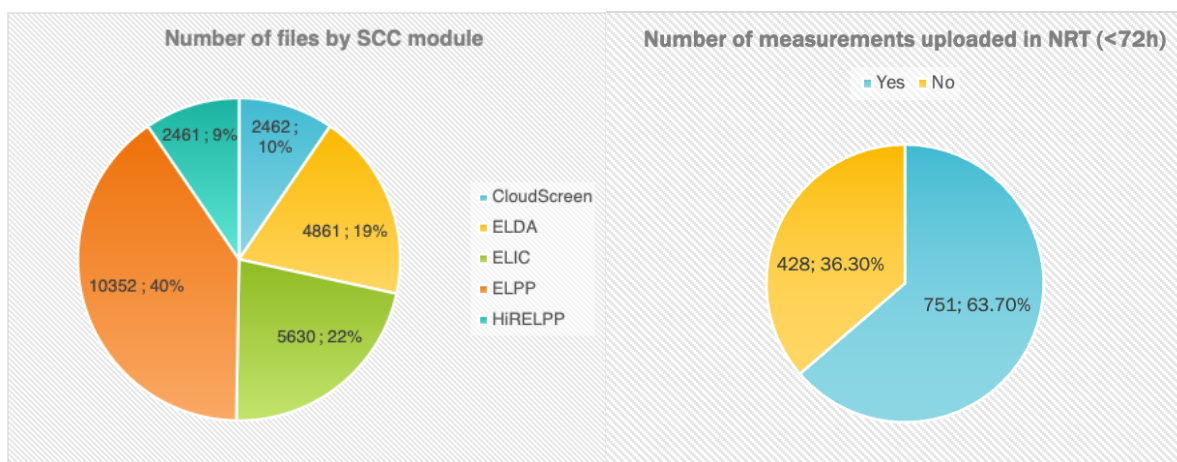


Figure 5 – AKY: Files processed by SCC and measurements uploaded in NRT

3.2 Barcelona, Spain - BRC

Automatic upload has been implemented at Barcelona reaching more than 90% of measurements uploaded in NRT on the database. Even in this case, the percentage of optical product files (ELDA) is around 20% probably as result of a typical good atmospheric condition for optical properties retrieval (Fig. 6).

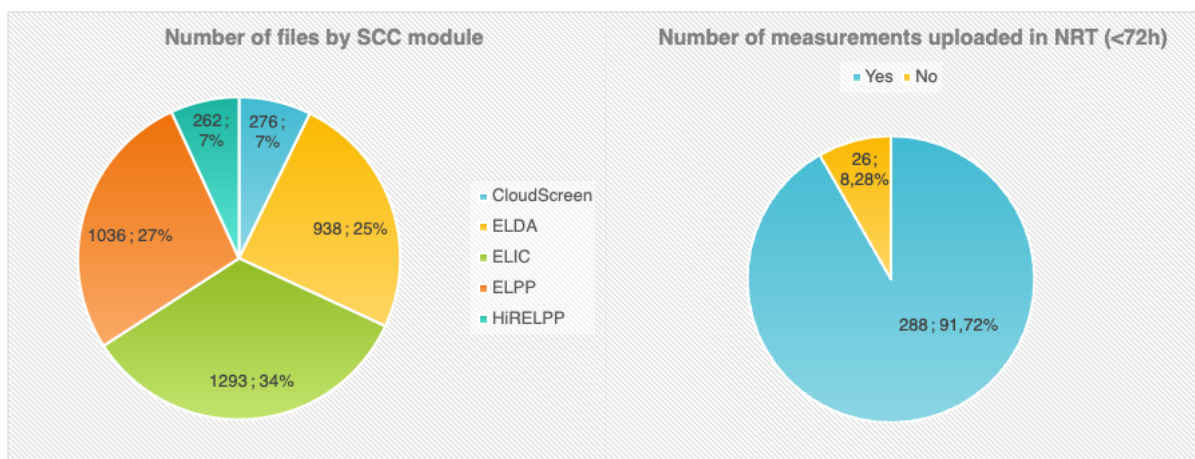


Figure 6 – BRC: files processed by SCC and measurements uploaded in NRT

3.3 Limassol, Cyprus - CYC

Limassol runs an automatic 24h working lidar. This is reflected in an also 100% of files submitted in NRT. Respect to the previous sites, outputs of calibration depolarization module (ELDEC) are provided too in larger number, since this procedure has been implemented routinely at the site. Here the percentage number of ELDA products is lower respect to previous reported sites maybe because



working 24h no preselection of observations has been done at the station (Fig. 7).

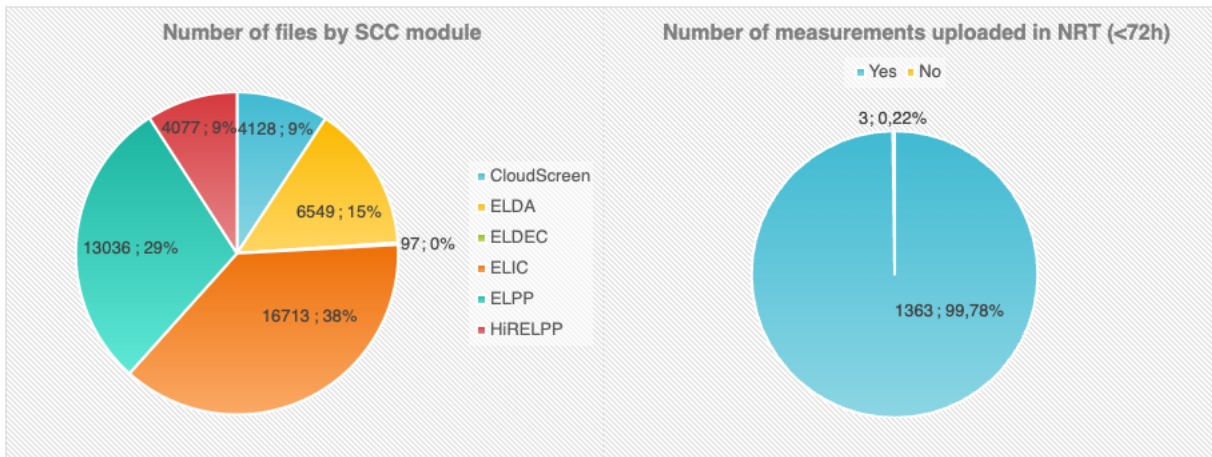


Figure 7 – CYC: files processed by SCC and measurements uploaded in NRT

3.4 Granada, Spain – GRA

A relative lower number of ELDA products is obtained also in Granada, reasons to be better investigated. Very good performances in terms if NRT provision is recorded here (85%) (Fig. 8).

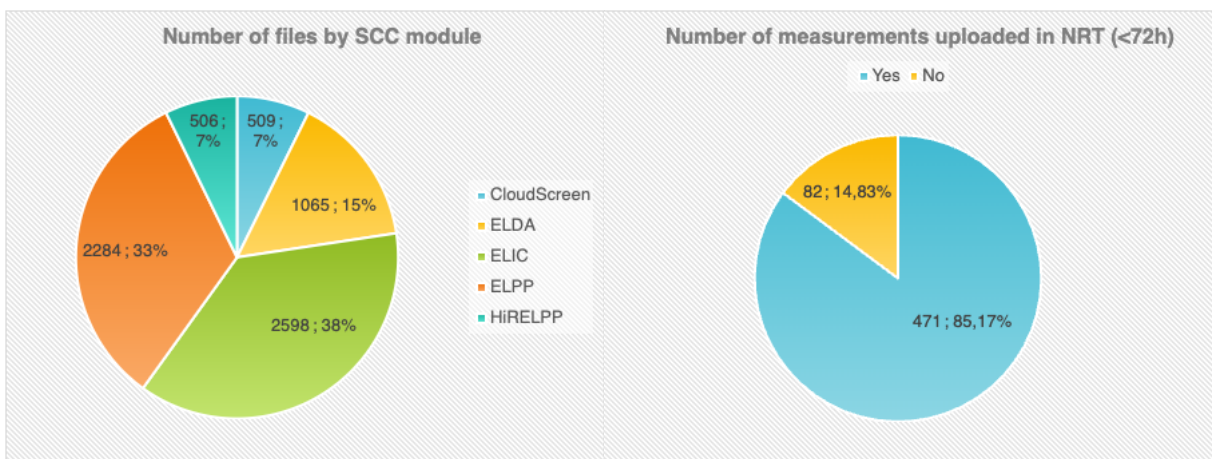


Figure 8 – GRA: files processed by SCC and measurements uploaded in NRT

3.5 Hohenpeissenberg, Germany - HPB

Even if on the Alps, Hohenpeissenberg shows a distribution in terms of output files similar to the ones recorded in AKY and BRC, and very good performance for NRT (Fig. 9).

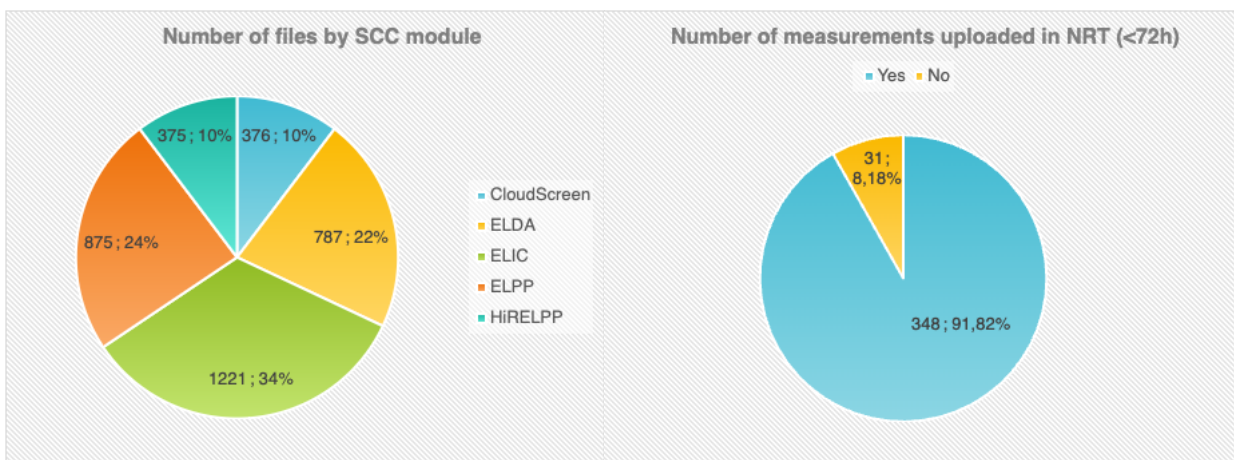


Figure 9 – HPB: files processed by SCC and measurements uploaded in NRT

3.6 Bucharest, Romania - INO

The manual upload implemented in Bucharest leads to about 17% of data not provided in NRT, which however is well above the expectations. A distribution of data products similar to the one of Granada is observed here (Fig 10).

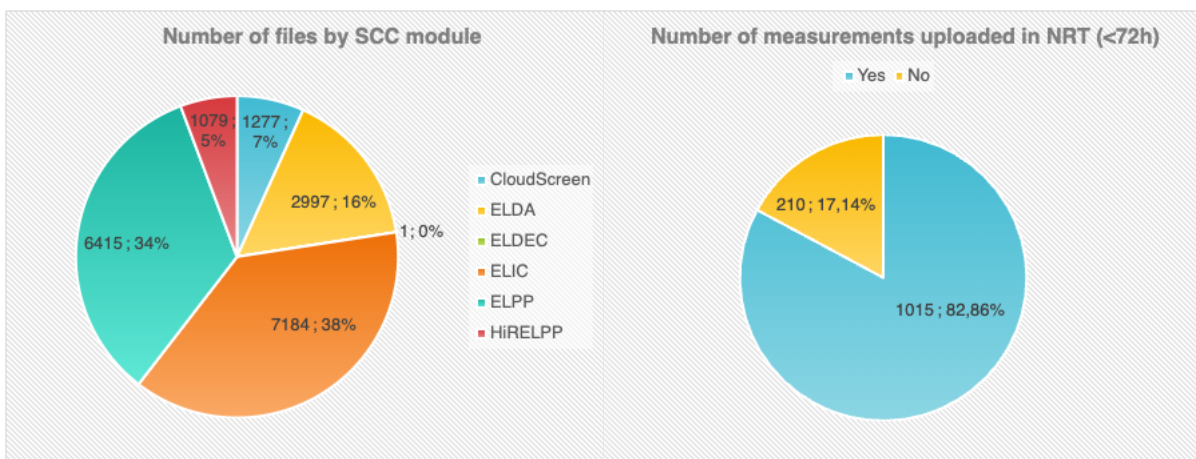


Figure 10 – INO: files processed by SCC and measurements uploaded in NRT

3.7 Kuopio, Finland – KUO

Kuopio works with a 24h operating lidar and automatic upload is implemented. A distribution of data products similar to the one of Granada and Bucharest is observed. Very good performance in NRT provision is obtained overcoming 90% (Fig. 11).

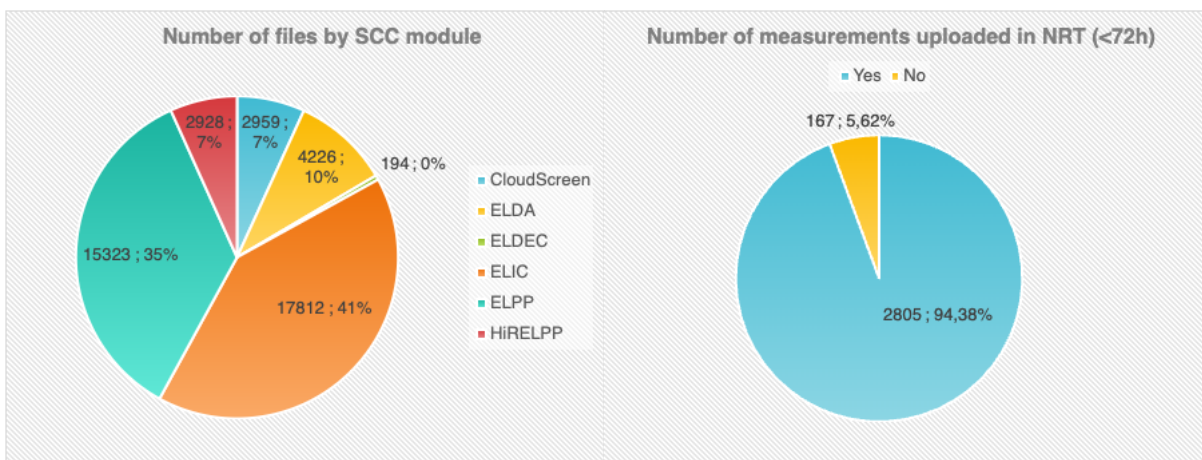


Figure 11 – KUO: files processed by SCC and measurements uploaded in NRT

3.8 Potenza, Italy – POT

A distribution of data products similar to the one of Granada, Bucharest and Kuopio is observed in Potenza. Almost 90% of the data are provided in NRT (Fig. 12).

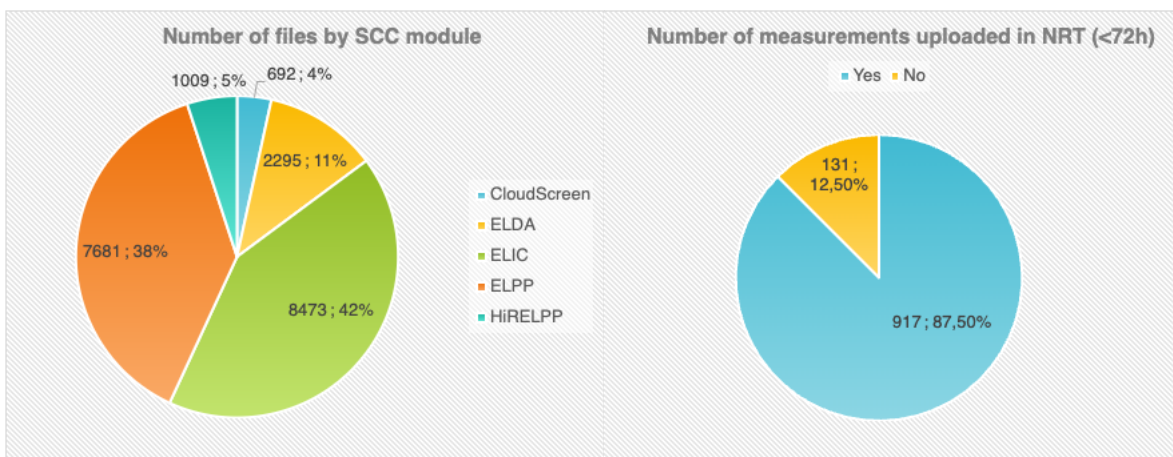


Figure 12 – POT: files processed by SCC and measurements uploaded in NRT

3.9 Thessaloniki, Greece – THE

In Thessaloniki, the percentage of ELDA products and in general the distribution of the data product types is similar to what observed for Hohenpeissenberg and Barcelona. Thessaloniki did not implement automatic upload to the ARES DC. The NRT provision for this station is the least efficient over the whole group, accounting for only 17% of data provided in NRT. Anyhow the modalities for the NRT provision could be improved in the future (Fig. 13).

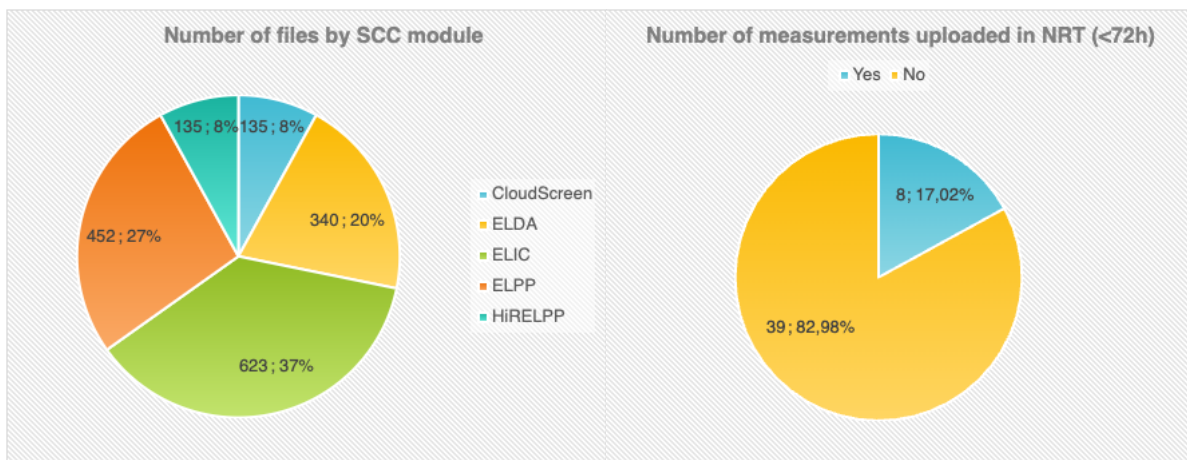


Figure 13 – THE: files processed by SCC and measurements uploaded in NRT

3.10 Warsaw, Poland - WAW

Warsaw works with a 24h operating lidar. A distribution of data products similar to the ones, for example, of Granada and Bucharest is observed. Even if with Warsaw data are uploaded manually to the RAES DC, very good performance (around 90%) in NRT provision is obtained (Fig. 14).

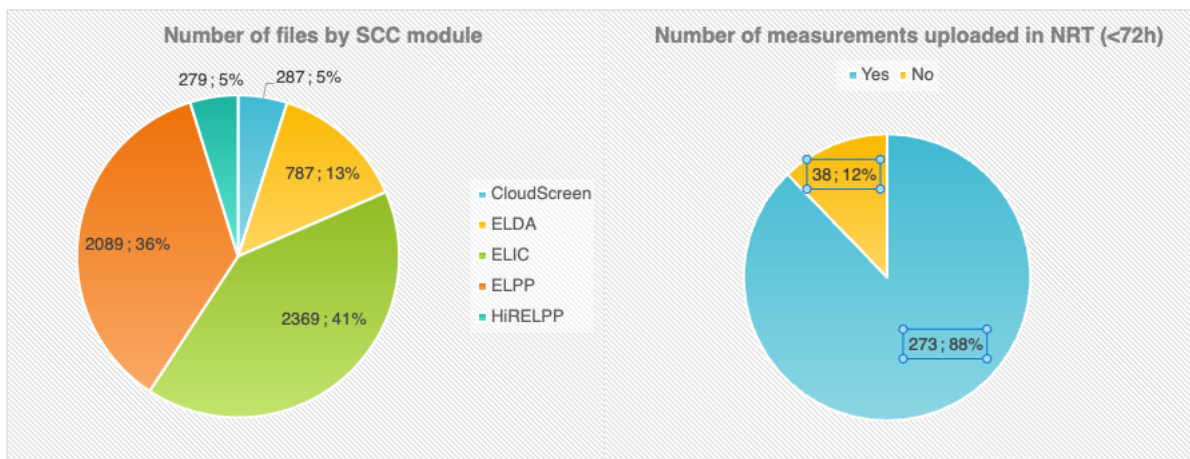


Figure 14 – WAW: files processed by SCC and measurements uploaded in NRT

4. Conclusions

This document summarizes the provision of ACTRIS/EARLINET data in 2024. The provision analysis shows that the involvement in the CAMS contract leads to a higher number of data provided from



participating stations.

Even if not mandatory for the contract, NRT provision has been successfully implemented by CAMS21b_2 stations: less than 10% of data are not provided in NRT by stations using automatic upload system, and below 25% for station manually uploading the files. The unique exception is Thessaloniki for which only 17% of data have been provided in NRT. Improvements are expected in the next period for this site.

Finally, Level 2, i.e. data compliant with all quality control procedures, are currently a small part of the whole provided dataset. This is due to delays in carrying out the QA tests for qualifying the lidar system in this implementation phase. Much more Level 2 data are expected in the next year for the new data and also for the reprocessing of 2024 data for which in the meanwhile lidar system will be qualified.



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