

HARMONIA CA21119

Deliverable 5.3c

Annual review of progress/achievements towards deliverables during MC meetings

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1. Introduction

It is the overall objective of the WG5 to establish mechanisms to disseminate the outcomes of the HARMONIA COST Action (CA21119) WG1-4 activities towards measurement improvement, new techniques and measurement approaches to aerosol scientists and instrument users (inside and outside the HARMONIA consortium). The main targets are:

- Present HARMONIA results to various structures dealing with aerosol measurements, including aspects of the entire processing chain; from measurement to end-user products.
- Disseminate and communicate scientific results and end user aerosol related activities towards different audiences (scientists, public, industry, government bodies).
- Exchange and combine software and hardware user tools among partners towards retrieval improvements.
- Publish scientific results of HARMONIA collaboration to peer reviewed journals, conferences, and reports.

This deliverable describes the progress, the achievements and all the networking activities regarding the five deliverables of the third year of the action, based on the discussions during the MC and the corresponding WG meetings. The five deliverables of the third year of the Harmonia action come from WG1, WG2, WG3 and WG4 and are respectively:

D1.3: Report on the cross validation experiments of synergies with co-located solar, lunar and stellar photometers on white and review papers.

D2.4: Report on uncertainties for optimized and homogenized products and suggestions for improving already existing products.

D3.1b: Share the recordings and the presentations of two Workshops that will be organized, with potential users from different interested communities, dealing with climate effects of aerosols, aerosol forecasting, air quality, renewable energy availability, and urban environments, from academia and operational agencies. The

deliverable D3.1b concerns the report for the second of the two workshops in Cyprus and it was transferred at the end of the third year of the COST action.

D3.2: Report on the requirements of different user communities on the accuracy, uncertainty and spatiotemporal resolution of aerosol measurements needed for their activities.

D4.1a: Share the recordings and the presentations of two Workshops that will be organized, with industrial users related with: technological needs and innovation actions. The deliverable D4.1a concerns the report for the first of the two workshops in Davos and it was transferred at the end of the third year of the COST action.

Following an MC vote (**Harmonia MC/WG meeting 25-26 February 2025 Faculty of Science, Sarajevo**), Deliverable D4.1b (“Organize a Workshop with industrial users related with technological needs and innovation proposed actions”) was transferred to the fourth year of the Action, when the second WG4 workshop will be organized.

2. Annual review for 3rd year deliverables

2.1 Deliverable D1.3

The main objective of the WG1 is the homogenization and harmonization of global aerosol measurements and retrievals. To achieve this goal networking is a key aspect since different instruments/networks and related algorithms have to be unified. The cooperation and the knowledge exchange inside the HARMONIA and specifically inside the WG1 aims to create a scientific roadmap on worldwide homogenization of aerosol properties' measurements including calibration, standard operation, quality assurance and control procedures and post processing.

D1.3 was originally planned for the second year of the Action and was transferred to the third year. Its official title in the Memorandum of Understanding (MoU) is:

Deliverable D1.3: "Report on the cross validation experiments of synergies with co-located solar, lunar and stellar photometers on white and review papers."

Discussions on D1.3 started at the online WG1 meeting of 10 December 2024. Members, and especially young scientists wishing to promote their work, were invited to propose contributions, and it was agreed that the scope of the deliverable could be broadened to accommodate relevant new topics. It has been also proposed to change the topic a bit to suit the content if needed and hence create an additional deliverable D1.4.

At the same meeting, M. Campanelli (WG2 leader) proposed a joint WG1–WG2 activity on lunar photometry algorithms ("lunar algorithm improvement").

At the fourth MC meeting in Sarajevo, WG1 leaders reported that D1.3 had been rescheduled for submission in autumn 2025 and presented ideas for its content. It was noted that the title selected at the proposal stage no longer fully reflected the Action's objectives, and a modified scope was proposed: in practice, D1.3 would summarize the related activities of HARMONIA members from mid-2024 to mid-2025. The first structure of the deliverable comprised:

- intercomparisons, harmonization initiatives, campaigns and experiments;

- cross-validation experiments, as in the official title, e.g. at Lindenberg, during measurement campaigns, other dual cross-validations, and at stellar photometry sites.

L. Doppler then outlined the topics to be discussed and worked on, which formed the basis for the separate WG discussions in the afternoon of the MC meeting:

- **Comparisons:** Prede/Cimel, Cimel/PFR and PFR/Prede at stations hosting pairs of these instruments, together with a common strategy for analysing the differences.
- **Synergies:** vertical/columnar (lidar, radiosondes) and lunar/solar/stellar.
- **Common HARMONIA retrieval:** reprocessing PFR, Cimel or Prede data with a common retrieval method (same air-mass and Rayleigh formulas and pressure value, same O₃ and NO₂ amounts).
- **Spectral / UV AOD.**
- **Grants:** STSM and VM topics proposed by the WG1 leaders, listed in the shared "PROJECTS" sheet.

Many members took part in the WG1 breakout session. L. Doppler presented its outcomes in the plenary, summarized below:

1. Intercomparisons

- a) **Prede-PFR-Cimel:** comparison strategies were discussed (including dual comparisons, e.g. PFR-Cimel, time matching, filtering and cloud flagging), together with the selection of sites and participants. A shared online document collects expressions of interest.
- b) **Solar-lunar-stellar:** this topic overlaps with WG2 and more contributors are needed; a shared online document is also available.

2. Spectral / UV AOD

- a) **High spectral resolution AOD in the VIS-NIR:** instruments and sites were discussed; the method still needs to be defined, building on Gröbner et al. (2023). Several members have registered their interest in a shared document.

- b) **UV AOD**: from different instruments, building on the work done so far; possible sites were discussed and interested members registered in a shared document.

3. Synergies

- a) **Stellar/lunar-solar (and possibly all-sky cameras)**: examining how the datasets complement each other.
- b) **Vertical (lidar, ceilometer, radiosonde)**: previous studies were reviewed and members were encouraged to contribute.

Applications of all kinds of grants were encouraged e.g. the VM of Yeser Aslanoglou using the Lindenberg dataset to compare AERONET lunar and solar AOD and to track events with HYSPLIT trajectories.

The topic of air masses, Rayleigh scattering and gas absorption was not covered, and interested members were encouraged to express their interest.

Outcome: given the breadth of the topics, D1.3 was moved, together with D1.4, to the fourth year of the Action.

2.2 Deliverable D2.4

The objective of the WG2 is to improve aerosol measurements using solar-, lunar- and star photometry, breaking new grounds for aerosol retrieval techniques including calibration improvement (via S.I. traceable related standardization results), hardware and software improvement actions. The exchange of knowledge and experience among manufacturers, calibration and data processing related scientists and users by establishing a network through HARMONIA, are the foundations for those improvements. The exploitation of existing measurement experimental data for different aerosol environments is one of the main sources of information for investigating and suggesting improvements of aerosol photometry measurement. The fourth deliverable of the WG2 is:

Deliverable D2.4: “Report on uncertainties for optimized and homogenized products and suggestions for improving already existing products.”

Preparation of D2.4 started after the online WG1 (10 December 2024) and WG2 (17 December 2024) meetings. Following the WG2 meeting of 17 December 2024, the WG2 leader e-mailed WG1 and WG2 members on 28 January 2025 proposing a review of the state of the art in lunar photometry, covering both data-analysis algorithms and calibration methods. Although much work has been done on this topic, the different methods have never been compared, and there is a strong need for harmonization for which the HARMONIA community is ideally placed. This work was also identified as preparatory to Deliverable D2.4. Members were invited to:

1. read a shared online document in which each section names the expert PIs who will mentor newcomers or coordinate contributors already active in the field;
2. add their name and e-mail address to the document if interested;
3. join a dedicated meeting of the interested members during the MC meeting in Sarajevo.

At the MC meeting in Sarajevo, WG2 presented its plans. The list of available projects (STSM and VM topics) remained open in a shared spreadsheet; some projects needed updating, which was addressed in the afternoon WG sessions.

Two actions were defined for D2.4:

1. a joint WG2–WG1 meeting dedicated to the improvement of the lunar photometer algorithm, with the date set through a Doodle poll among the interested members;
2. a comparison of climatologies from the AERONET, SKYNET and PFR networks, building on point 5 of Deliverable D2.2 (comparison of AERONET and SKYNET retrievals under different conditions in Rome, Italy).

Outcome: D2.4 was moved to the fourth year of the Action.

2.3 Deliverable D3.1b

The objective of the WG3 is to increase the applicability for aerosol optical properties for different scientific fields. HARMONIA network and specifically WG3 aims to link the accuracy and uncertainty of aerosol optical properties to the objectives and

needs of the climate and atmospheric related scientific community and relevant structures (e.g. WMO, GCOS, satellite related missions) and to create interacting mechanisms with users (Climate scientists, air quality, solar energy, aviation and others). The expertise of diverse groups in HARMONIA (ground-based aerosol monitoring, satellite monitoring, atmospheric modelling, etc.) and the networking activities are essential in fulfilling those objectives.

The organization of dedicated workshops to bring together users from all communities (e.g., Academia, industry, operational agencies, research structures, EU and WMO research services) is the best way to maximize the use of ground-based aerosol measurements and with this is related the second Deliverable of WG3:

D3.1b: "Share the recordings and the presentations of two Workshops that will be organized, with potential users from different interested communities, dealing with climate effects of aerosols, aerosol forecasting, air quality, renewable energy availability, and urban environments, from academia and operational agencies."

At the MC meeting in Sarajevo, it was decided to organize the second WG3 workshop in June 2025 in Limassol, Cyprus, and to start preparations, including the choice of speakers and the exact dates. As another workshop was taking place at the same time, S. Kazadzis suggested dedicating one day to HARMONIA and combining the two events so that HARMONIA members could join both.

During the WG3 session, the WG3 leaders noted that much work was still ongoing and decided to announce VM grants to combine the material from the first WG3 workshop (Athens) and the second (Cyprus) with the outputs of the WG3-related VMs, and to compile the reports due in October 2025. All the material was available and needed to be compiled.

The HARMONIA workshop "Aerosol data users and applications" was held successfully on 16–17 June 2025 at the ERATOSTHENES Centre of Excellence in Limassol, Cyprus, with more than 30 participants from different scientific fields. The VM grant of Florica Toanca contributed to compiling the report.

Outcome: D3.1b has been delivered and is available at <https://harmonia-cost.eu/wp-content/uploads/2025/10/Harmonia D3.1b final.pdf>.

2.4 Deliverable D3.2

The second deliverable of WG3 addresses the requirements of the user communities:

D3.2: "Report on the requirements of different user communities on the accuracy, uncertainty and spatiotemporal resolution of aerosol measurements needed for their activities."

At the online WG3 meeting in November 2024, the WG leaders proposed VM grants for this deliverable. Material from completed grants was already available and was presented, and a contributor was needed to compile it. Two VMs completed in autumn 2024 provided input:

- **Sophie Vandenbussche**, *"Link to AeroCom and AeroSAT communities"* (15/09/2024–25/10/2024). The VM linked HARMONIA with the AeroCom and AeroSAT communities, both end users of ground-based photometer observations and therefore targets of WG3 (end-user engagement towards maximizing aerosol measurement use). Interaction with these communities provides relevant information for D3.2 and D3.3 (white paper on sun-photometric aerosol accuracy and uncertainty for different applications), and established contacts with potential speakers for the second WG3 workshop.
- **Panagiotis Fountoukidis**, *"Assessing the accuracy, uncertainty and spatiotemporal resolution of space-borne aerosol index products on geostationary and polar orbits"* (09/09/2024–15/10/2024).

At the MC meeting in Sarajevo, two further VMs were ongoing, with their reports pending:

- **Maja Kuzmanovski**: *"Bibliographical review: the role of aerosol optical properties uncertainties in the modelling of solar radiation and solar energy"*
- **Nikos Papadimitriou**: *"Assessment of aerosol related uncertainties in solar energy modelling"*

Ideas for preparing D3.2 on the basis of the available VM studies were presented, and members were invited to become actively involved through the two related VMs. As for D3.1b, it was decided to announce VM grants to combine the material from the two WG3 workshops and the WG3-related VMs into the report, due in October 2025. The VM grant of Florica Toanca contributed to compiling the report.

Outcome: D3.2 has been delivered and is available at <https://harmonia-cost.eu/wp-content/uploads/2026/02/D32.pdf>.

2.5 Deliverable D4.1a

WG4 addresses the challenge: how can scientists improve aerosol measurement quality and future measurement capabilities, including low-cost sensors? Its approach (Objective 4) is to establish an interdisciplinary team of scientists dealing with aerosol measurements and their use, together with industrial instrument developers, in order to report on the current status of measurement uncertainty and on future technical needs, and to suggest innovative ideas for the future of aerosol remote sensing sensors and retrieval methods.

The first deliverable of WG4 relates to the first WG4 workshop:

D4.1a: "Share the recordings and the presentations of two Workshops that will be organized, with industrial users related with: technological needs and innovation actions."

At the MC meeting in Sarajevo, the WG4 meeting and first WG4 workshop were announced for 8–9 October 2025 in Davos, alongside the sixth Filter Radiometer Comparison (FRC-VI); manufacturers of sky cameras and handheld photometers were to be invited.

The first WG4 workshop was held at the Physikalisch-Meteorologisches Observatorium Davos / World Radiation Center (PMOD/WRC) on 8 October 2025. It brought together more than 20 participants, most of whom attended in person. The VM grant of Miguel Huerta Gómez contributed to compiling D4.1a which is available at this link https://harmonia-cost.eu/wp-content/uploads/2026/02/Harmonia_VM_WG4_davos.pdf.

References

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