

## Report on the outcomes of a Virtual Mobility<sup>1</sup>

**Action number: CA21119**

**Grantee name: Maciej Karasewicz**

### **Virtual Mobility Details**

Title: Improvement of aerosol data products with use of Doppler Lidar: aerosol flux (DLiAF)

### **Description of the work carried out during the VM**

The main aim of the DLiAF Virtual Mobility, carried out in collaboration between the University of Warsaw (UW; M. Karasewicz, L. Janicka and I.S. Stachlewska), the National Institute for Research and Development in Optoelectronics (INOE; L. Belegante), and the Leibniz Institute for Tropospheric Research (TROPOS; R. Engelmann), was to improve the classical aerosol data retrieval by utilizing the Doppler lidar-derived aerosol flux products.

Aerosol fluxes are strictly connected to fluctuations in the aerosol backscatter coefficient, and therefore they directly affect the accuracy of aerosol optical properties assessments, particularly in calculations based on temporal averages. We demonstrated the potential for multi-site analyses of vertical aerosol fluxes using Doppler lidar techniques.

The analysis of the databases from four different locations has been conducted for the spring season. Aerosol flux transport velocities were obtained for three ACTRIS-CLOUDNET sites: Warsaw (UW, ACTRIS National Facility, Poland), Magurele (RADO-Bucharest, ACTRIS National Facility, Romania), and Juelich (Jülich Observatory for Cloud Evolution (JOYCE), ACTRIS National Facility, Germany), as well as for Innsbruck (University of Innsbruck, Austria).

The first step involved adapting the methodology for Doppler lidar aerosol-flux retrieval developed at UW, which now consists of synergic use of the Doppler Lidar, Microwave Radiometer and Disdrometer. It was then applied to CLOUDNET-based data (Warsaw, Magurele, and Juelich) and non-CLOUDNET-based data (Innsbruck). Then, data selection was performed to isolate a specific measurement period during which most instruments were simultaneously operational: specifically, the spring season (March, April, May) 2024 for the CLOUDNET data, and in the period of 14 to 22 March 2024 for the Innsbruck data. Collaborative discussions allowed for improvement of the methodology with additional data screening and re-defining necessary assumptions for data analysis. Based on the comprehensive results from all stations, the optimal approach was determined and applied to an extended database containing data from different seasons in three years period (2022–2024) in Warsaw, leading to the very first complete aerosol fluxes characterisation in the urban environment (publication to be submitted to the HARMONIA CA Special Issue in ACP/AMT).

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<sup>1</sup> This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the Grant Holder Manager to verify the grant documents compliance and proceed with the payment.

Ultimately, the finalized methodology that applied to all four stations was enabling a direct comparison of the results, exposing limitations of the approach, and allowing for the definition of requirements for implementing it within the CLOUDNET Database in the future.

Thanks to the DLiAF Virtual Mobility joint collaboration conducted between 1 and 30 April 2026, communication maintained via email/phone, and several in-person meetings between UW participants, all of the planned DLiAF goals were achieved.

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### **Description of the VM main achievements and planned follow-up activities**

The data analysis revealed the necessary steps for using the proposed technique across CLOUDNET sites and their databases. Based on these results, a requirements list was created, outlining the criteria for optimal aerosol flux characterization at different stations. An extended scientific report containing all results and conclusions was also prepared and shared with the DLiAF Virtual Mobility collaborators.

A comprehensive characterization of multi-year and multi-seasonal aerosol fluxes in Warsaw was described in a joint draft manuscript by Karasewicz M., Janicka L., Engelmann R., Belegante L. and Stachlewska I.S., *"Characteristics of vertical aerosol fluxes in the urban ecosystem based on long-term Doppler lidar measurements in Warsaw" (preliminary title)*. We planned submission of this work into the Special Issue of HARMONIA CA21119: *Sun-photometric measurements of aerosols: harmonization, comparisons, synergies, effects, and applications (AMT/ACP inter-journal SI)*.

Additionally, our findings for the four-station comparison/analyses will be presented by one of the contributors Lucja Janicka, at the upcoming 32<sup>nd</sup> International Laser Radar Conference (ILRC) in Hiroshima, Japan (2026) in a poster presentation entitled *"Roadmap for Lidar-Derived Aerosol Fluxes in the Urban Atmospheric Boundary Layer Across European Cities"*.

Finally, the project participants plan to publish the comparative results from all stations, including the comprehensive list of requirements, in a joint publication (draft under preparation).

In all of the aforementioned dissemination activities, the Harmonia COST Action is listed in the Funding/Acknowledgements section.

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