ATMO ACCESS
Access to Atmospheric Research Facilities

Activity report of the TNA to ATMO-ACCESS research infrastructures

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004

ATMO ACCESS
Access to Atmospheric Research Facilities

Name and First Name: Afwan Hafiz

TNA title and acronym: Towards the development of FLUorescence-MIe-RAman mobile lidar (FLUMIRA)

Facility/ies accessed: RADO-MARS (INOE)

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004

Instructions

Please limit the report to max 3-5 pages, including tables and figures.
The report should be sent as pdf document and include the subheadings listed below. Please make sure to address any comments made by the reviewers (if applicable).

Is the information provided in the report confidential and should not be made available on the ACTRIS website?

☒ No, the information can be made public.

☐ Yes, the information should not be made public and access should be restricted to the TNA Team, the ATMO-ACCESS access providers, the reviewers concerned and the ATMO-ACCESS Strategic TNA Board.

Table of Contents

1. Short executive summary (can be made available to reviewers and EU experts) 4
2. User group 4
3. Scientific objectives 6
4. Reasons for choosing the Facility/ies 6
5. Activities during the TNA (research, training, events, …) 6
6. Method and set-up of research 7
7. Preliminary project results and conclusions 7
8. Outcomes and future studies 8
9. Plans for publications 9
10. References 9

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004

1. Short executive summary (can be made available to reviewers and EU experts)

A TNA project was realized in physical format at the ACTRIS RADO-MARS (INOE) between members from the RS-Lab (Warsaw) team: Afwan Hafiz and Zuzanna Rykowska; and the RADO-MARS (Bucharest) team: Doina Nicolae, Anca Nemuc, Jeni Vasilescu, Livio Belegante, Viktor Nicolae. The project, entitled "FLUMIRA", is contributing to the development of synergy measurement between Fluorescence and Raman technique of the ESA Mobile Raman Lidar (EMORAL) developed within the POLIMOS project led by prof. Iwona Stachlewska at the University of Warsaw. The goal is to study the advantages of fluorescence in measuring the biological particles, assess potential information for chemical characterization of biological-based aerosol that could be provided by multi-wavelength Mie-Raman lidar and investigate synergy between fluorescence and Mie-Raman capacities of the lidar.

2. User group

Complete the table with details of the user group members who actually accessed the Facility. Duplicate the table below for each member of the user group.

Information on the User group members	
Member # 1	
First and last name	Afwan Hafiz
Gender	☐ Female ☒ Male ☐ Prefer not to say
Nationality	Indonesia
Profile	☐ Undergraduate ☒ Postgraduate ☐ Expert scientist ☐ Engineer, Technician ☐ Other
Field of activity	☒ ENV-ATMO - Earth and environmental sciences/Atmospheric domain ☐ ENV-HYDRO - Earth and environmental sciences/Hydrosphere domain ☐ ENV-LITHO - Earth and environmental sciences/Lithosphere ☐ ENV-ECOBIO - Earth and environmental sciences/Eco-biosphere ☐ PHY - Physics astronomy, astrophysics and mathematics ☐ CHEM - Chemistry and material sciences ☐ BIO-MED - Biological, medical sciences and biotechnology ☒ ENG-TECH - Engineering and technology ☐ EGY - Energy ☐ ART - Humanities and arts ☐ ISC - Information science and communication

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004

	☐ SOC - Social sciences		
Are you a new user?	☒ Yes		
	☐ No		
Institution name (employer)	University of Warsaw – Faculty of Physics		
Institution legal status (employer)	☐ Public research (including international research organizations and private research organization controlled by a public authority) ☒ University and higher education ☐ Public authority ☐ Small Medium Enterprise (SME) ☐ Other industrial and/or profit private organization ☐ Other		
Address (employer)	Warsaw, Pasteura 5	**Country**	Poland
Email address	a.hafiz@student.uw.edu.pl		
Access start date	17/11/2022	**Access end date**	01/12/2022

Information on the User group members	
Member # 2	
First and last name	Zuzanna Rykowska
Gender	☒ Female ☐ Male ☐ Prefer not to say
Nationality	Poland
Profile	☒ Undergraduate ☐ Postgraduate ☐ Expert scientist ☐ Engineer, Technician ☐ Other
Field of activity	☒ ENV-ATMO - Earth and environmental sciences/Atmospheric domain ☐ ENV-HYDRO - Earth and environmental sciences/Hydrosphere domain ☐ ENV-LITHO - Earth and environmental sciences/Lithosphere ☐ ENV-ECOBIO - Earth and environmental sciences/Eco-biosphere ☐ PHY - Physics astronomy, astrophysics and mathematics ☐ CHEM - Chemistry and material sciences ☐ BIO-MED - Biological, medical sciences and biotechnology ☐ ENG-TECH - Engineering and technology

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004

	☐ EGY - Energy ☐ ART - Humanities and arts ☐ ISC - Information science and communication ☐ SOC - Social sciences		
Are you a new user?	☒ Yes ☐ No		
Institution name (employer)	University of Warsaw – Faculty of Physics		
Institution legal status (employer)	☐ Public research (including international research organizations and private research organization controlled by a public authority) ☒ University and higher education ☐ Public authority ☐ Small Medium Enterprise (SME) ☐ Other industrial and/or profit private organization ☐ Other		
Address (employer)	Warsaw, Pasteura 5	**Country**	Poland
Email address	a.hafiz@student.uw.edu.pl		
Access start date	17/11/2022	**Access end date**	01/12/2022

3. Scientific objectives

The main objective of this TNA is to study the feasibility and potential of building a synergy between fluorescence and Mie-Raman LIDAR in ESA Mobile Atmospheric Lidar (EMORAL). The combination of Fluorescence and Mie-Raman LIDAR in atmospherics study offers two interesting features. Firstly, as the fluorescence technique has multiple advantages in measuring the biological particles in the atmosphere, the synergy measurement with multi-wavelength Mie-Raman LIDAR could provide significant information for the chemical characterization of biological-based aerosol. Secondly, due to the high backscatter coefficient by the clouds for Mie-Raman methods, conducting an aerosol measurement in the presence of clouds is challenging. Since water molecules do not have fluorescence, the fluorescence technique thus could be a prominent tool to monitor aerosol that exists inside the clouds.

4. Reasons for choosing the Facility/ies

RADO-MARS was selected as the facility to visit under the consideration that the facility has an extensive experience in the field of characterization of the atmosphere using a synergy of active and passive remote sensing instruments along with modelling and satellite data which is considered an important aspect to reach the planned scientific objectives.

5. Activities during the TNA (research, training, events, ...)

Several activities were caried out during the TNA: (i) Training of lidar basic which includes theoretical introduction, lidar operation, quality assurance, SCC setup, and automatic data submission using OBIWAN; (ii) hands-on training of lidar operation; (iii) preprocessing and optimization of lidar signal; and (iv)

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004

Discussion on fluorescence technique for biological-matter detection and the synergy measurement of fluorescence and Mie-Raman.

6. Method and set-up of research

The visit was dedicated to study the potential information that could be access by combining fluorescence and Mie-Raman results in terms of aerosol within boundary layer (including fog, smog) and clouds. The method used during the visit consisted of trainings focused on lidar and related topics and discussions on fluorescence technique and potential synergetic measurement.

7. Preliminary project results and conclusions

The main preliminary results obtained during the TNA was the result of quality assurance procedure performed on lidar data collected during Intercomparison campaign at RADO-MARS in September 23rd – October 1st, 2022. The preprocess and quality assurance routine was performed mainly with LabVIEW-based software developed by Livio Belegante.

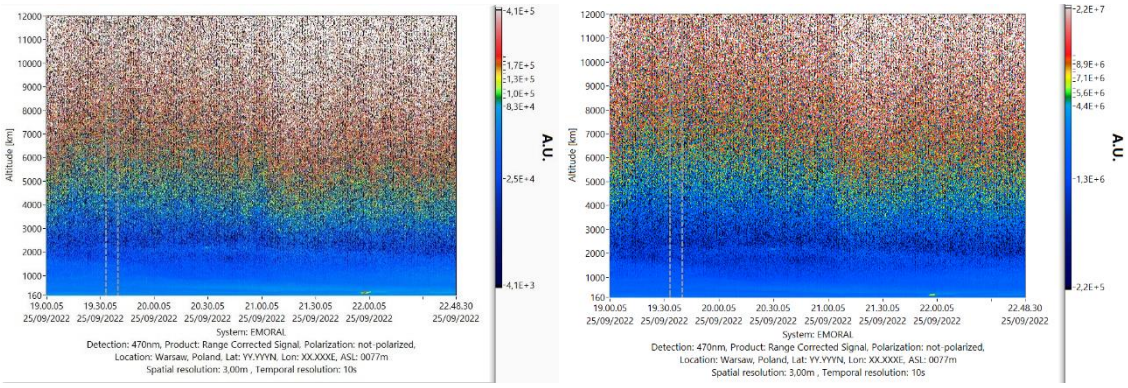
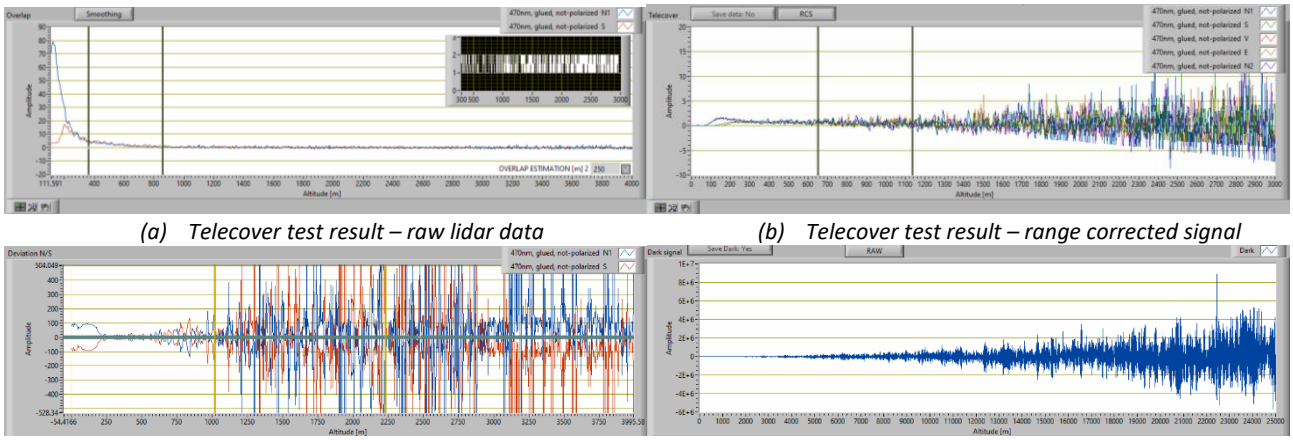


Figure 1 *Range Corrected Signal of channel 470nm (left) analog mode and (right) photon counting mode processed from data taken on September 25th, 2022 in Bucharest.*

The first result shown is the range-corrected-signal (RCS) of spatio-temporal profile of newly added fluorescence channel at 470 nm. **Figure 1** shows the profile of data collected at 25th of September. One can observe some patterns below 2000 m and at around 200 m of altitude that need to be further investigate to understand their origins. The second results are connected to preprocessing procedure of lidar data: Telecover test, dark substraction, and Rayleigh fit.



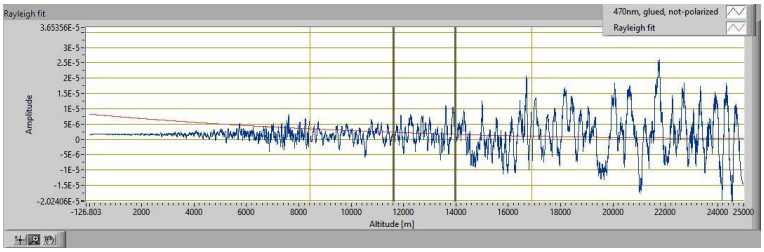
(a) Telecover test result – raw lidar data

(b) Telecover test result – range corrected signal

(c) Telecover test result – deviation of relative mean

(d) Dark signal – range corrected

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004



(e) Rayleigh fit result

***Figure 2** Preprocessing results performed on data obtained at September 25, 2022.*

As can been seen on **Figure 2 (a)**, the full overlap for channel 470 is estimated at 250 m, while **Figure 2** (b) and **Figure 2** (d) shows an indication that the subtraction of dark signal need to be checked again to confirm if dark substraction was done properly. On the other hand, **Error! Reference source not found.** (e) shows the result of Reyleigh Fit test for channel 470 nm, performed on data coleected on 23rd of September. The result indicates a poor quality as one can see that the lidar signal is below the Rayleighfit (in red). This needs to be further investigate to confirm the if the current test result is really from the the quality of channel 470 nm.

The calculation of GHK parameters that are necessary in Depolarization calibration was also performed on prebuilt scripts with current parameters of EMORAL Lidar for both channel 355 nm and 532 nm. The calculation result are shown in **Table 1**.

***Table 1.** Depolarization Calibration Parameters for EMORAL*

Channel	Parameters				
	GR	GT	HR	HT	K
355 nm (UV)	1.00000	1.00000	0.97933	-0.97993	1.00000
532 nm (VIS)	1.00000	1.00000	0.97759	-0. 97759	1.00000

Additionally, optimization was also conducted on RALI lidar to reduce the background by constructing additional blocker piece placed on the field stop of RALI's telescope (see **Figure 3**). The idea was to also later use the constructed piece for EMORAL's telescope since the initial designs of both EMORAL and RALI were identical. Unfortunately, the quality of RALI data equipped with the constructed piece could not properly assessed due to the bad weather conditions.

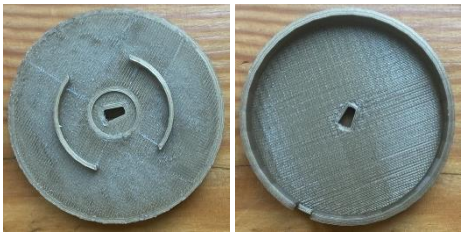


***Figure 3**. Photograph of background blocker, top side (left) and bottom side (right)*

8. Outcomes and future studies

The following steps to be deeply explored for realizing synergy between fluorescence and Mie-Raman LIDAR in EMORAL. First, further assess the quality of newly added 470 channel and optimize it with by installing the constructed background blocker (if applicable). Second, developing the synergy measurement of Fluorescence and Mie-Raman with the information obtained during the TNA and the most recent paper by I. Vesolovskii et.al., 2022 as the basis.

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004

9. Plans for publications

The results of this TNA will be used as inputs and basis for my PhD study. Interesting results and outputs of the work will be published in Optics Express (R&D related) and Atmospheric Environment, Atmospheric Research (science related) to be prepared and published within 2022-2033.

I am planning also to present this TNA work during one of the conferences and workshops organized by ACTRIS.

10. References

Volker Freudenthaler, "European Aerosol Research Lidar Network – Advanced Sustainable," vol. 6604, no. April, pp. 1–7, 2007.

R. Pîrloagă, D. Ene, M. Boldeanu, B. Antonescu, E. J. O'Connor, and S. Ştefan, "Ground-Based Measurements of Cloud Properties at the Bucharest–Măgurele Cloudnet Station: First Results," *Atmos. 2022, Vol. 13, Page 1445*, vol. 13, no. 9, p. 1445, Sep. 2022, doi: 10.3390/ATMOS13091445.

Veselovskii, Q. Hu, P. Goloub, T. Podvin, B. Barchunov, and M. Korenskii, "Combining Mie-Raman and fluorescence observations: a step forward in aerosol classification with lidar technology," *Atmos. Meas. Tech.*, vol. 15, no. 16, pp. 4881–4900, 2022, doi: 10.5194/amt-15-4881-2022.

Claus Weitkamp, Ed., *Lidar: Range-Resolved Optical Remote Sensing of the Atmosphere*. Singapore: Springer, 2005.

V. Freudenthaler, H. Linné, A. Chaikovski, D. Rabus, and S. Groß, "EARLINET lidar quality assurance tools," *Atmos. Meas. Tech. Discuss.*, no. January, pp. 1–35, 2018.

L. Belegante *et al.*, "Experimental techniques for the calibration of lidar depolarization channels in EARLINET," *Atmos. Meas. Tech.*, vol. 11, no. 2, pp. 1119–1141, 2018, doi: 10.5194/amt-11-1119-2018.

V. Freudenthaler, H. Linné, A. Chaikovski, D. Rabus, and S. Groß, "EARLINET lidar quality assurance tools," *Atmos. Meas. Tech. Discuss.*, no. January, pp. 1–35, 2018.

This work has received funding from the European Union's Horizon 2020 research and innovation programme through the ATMO-ACCESS Integrating Activity under grant agreement No 101008004