Lidar Vertical Profile Analyzes at National Atmospheric Observatory Košetice during Volcano Eruption on La Palma Island.

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LIDAR VERTICAL PROFILE ANALYZES AT NATIONAL ATMOSPHERIC OBSERVATORY KOŠETICE DURING VOLCANO ERUPTION ON LA PALMA ISLAND

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INTRODUCTION

Volcanic eruptions are one of the most important sources of natural aerosol (Ravindra Babu et al., 2022; Tomasi et al., 2017). Their negative impacts on air quality (the effects of volcanic exhaust) can be observed via long-range transport to locations far from the eruption (Kvietkus et al., 2013; Ravindra Babu et al., 2022; Revuelta et al., 2012). One of the most recent events of volcanic activity was a volcanic eruption on La Palma in the fall of 2021 (Cumbre Vieja Volcano, La Palma Island, Canary Islands, 28°36'54 "N 17°52'07 "W, 1,949 m a.s.l.). The impact of the volcanic eruption on air quality, which occurred 3600 km from the National Atmospheric Observatory Košetice, was studied using a combination of ground-based measurements and vertical profile analyzes. Since a new instrument (LIDAR) has extended the equipment of our station, vertical profile analyzes were performed.

EXPERIMENTAL SETUP

Air quality was analyzed at the National Atmospheric Observatory Košetice (NAOK - 49°34'24 "N, 15°4'49 "E, 534 m a.s.l.) from September 1 to October 31, 2021. NAOK is a rural background station located in the Czech-Moravian Highlands, in the central part of the Czech Republic. Vertical profile characteristics were measured using LIDAR (LR211-D300, Raymetrics). The measurement principle of LIDAR is to emit a laser beam into the atmosphere, which is scattered by particles. Part of the emitted light is scattered back to the LIDAR's telescope. Based on the time it takes for the light to return, the distance of the aerosol layers can be determined. The received power due to elastic scattering can be described by the lidar equation (1) (Raymetrics SA, 2020). The meaning of the variables can be found in Baars (2007) and Baars (2011).

$$P(z) = P_0 \frac{c\tau}{2} \beta(z) A_{tel} O(z) \frac{1}{z^2} \exp\left[-2\int_0^z a(z^*)dz^*\right] \tag{1}$$

Air quality measurements were performed with automatic analyzers: SO_2 (T100U, Teledyne Advanced Pollution Instrumentation); PM_{10}, $PM_{2.5}$ (MP101M Environnement SA), Hg_0 - (2537B, Tekran), SO_4, NO_3 - custom-made sampler (according to EMEP).

RESULTS AND CONCLUSIONS

During the period studied, there were two dates when the volcano's SO_2 plume passed over central Europe – September 26 and October 20. From about 8:00 p.m. on September 26 to 3:00 a.m. on September 27, several layers at altitudes of 10-12 km were recorded by LIDAR (Fig. 1). A huge increase in the backscatter coefficient (up to $1.6 \cdot 10^{-5}$ m^{-1} sr^{-1}) was observed at altitudes of 10-12 km during 24 hours (from 25 September to 26 September) (Fig. 2).

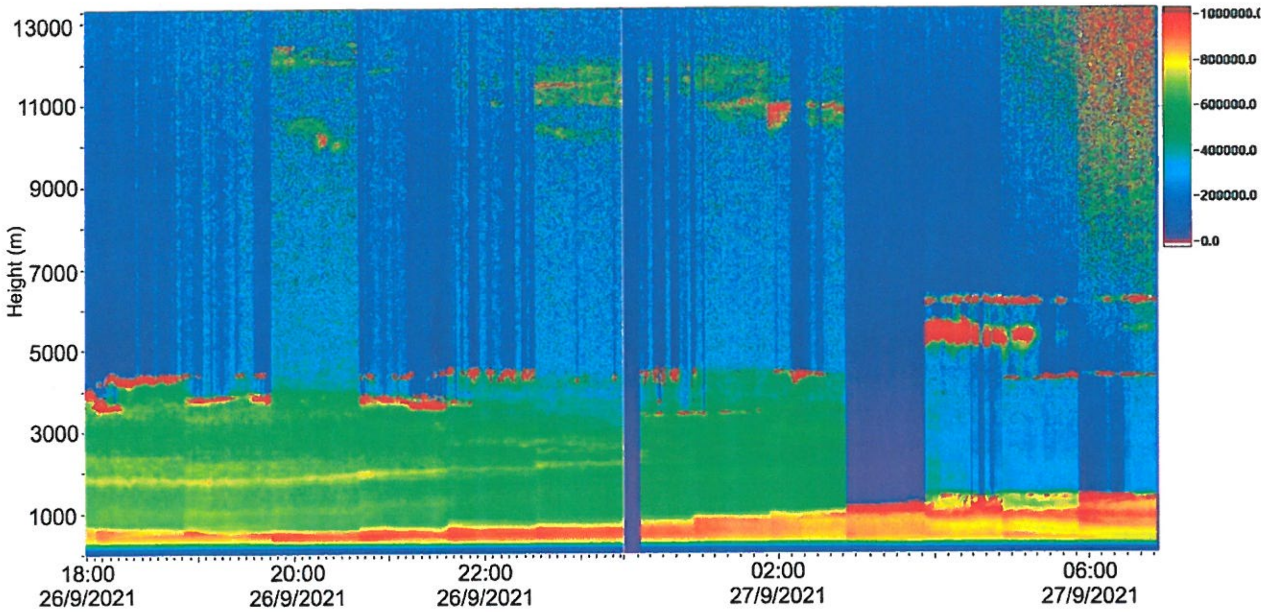

Fig. 1: Lidar measurements from 09/26/2021 to 09/27/2021. Time series of the range-corrected signal for the 355 nm channel.

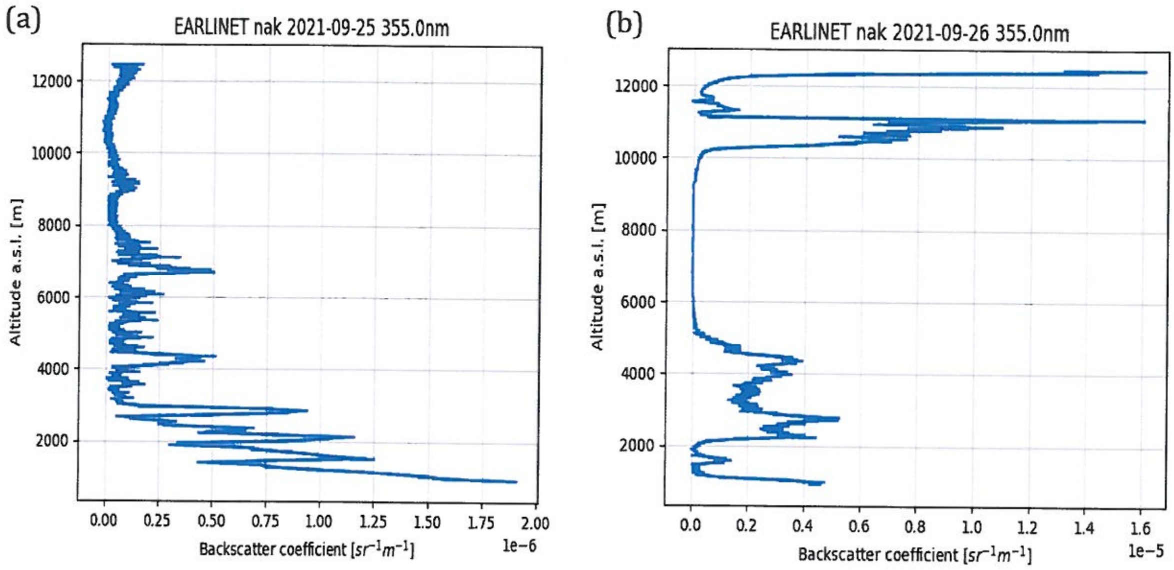

Fig. 2: 355 nm particle backscatter coefficient observed on 25 September 2021, 18:02 – 18:21 UTC (a), on 26 September 2021, 20:02 – 20:21 (b) processed in SCC platform (19 min signal average).

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REFERENCES

Babu, S. R., Nguyen, L. S. P., Sheu, G. R., Griffith, S. M., Pani, S. K., Huang, H. Y., & Lin, N. H., Long-range transport of La Soufrière volcanic plume to the western North Pacific: Influence on atmospheric mercury and aerosol properties. *Atmospheric Environment, 268*, 118806 (2022).

Tomasi, C., Fuzzi, S., & Kokhanovsky, A. (Eds.). *Atmospheric aerosols: life cycles and effects on air quality and climate.* John Wiley & Sons. (2017).

Santoso, M., Lestiani, D. D., Kurniawati, S., Damastuti, E., Kusmartini, I., Atmodjo, D. P. D., Suprayadi, L. S. Assessment of urban air quality in Indonesia. *Aerosol and Air Quality Research*, 20, 2142-2158., (2020).

Kvietkus, K., Šakalys, J., Didžbalis, J., Garbarienė, I., Špirkauskaitė, N., & Remeikis, V. Atmospheric aerosol episodes over Lithuania after the May 2011 volcano eruption at Grimsvötn, Iceland. *Atmospheric research*, 122, 93-101. (2013).

Revuelta, M. A., Sastre, M., Fernández, A. J., Martín, L., García, R., Gómez-Moreno, F. J., Molero, F. Characterization of the Eyjafjallajökull volcanic plume over the Iberian Peninsula by lidar remote sensing and ground-level data collection. Atmospheric Environment, 48, 46-55. (2012).

LR211-D300 Depolarization Raman LIDAR, Raymetrics SA, (2020).

Baars, H. Continuous monitoring of the planetary-boundary-layer depth with lidar. Master's thesis, Universität Leipzig, Germany, (2007).

Baars H., Dissertation thesis, University of Leipzig. Dissertation thesis, Aerosol profiling with lidar in the Amazon Basin during wet and dry season (2011).