COMPARISON OF AEROSOL VERTICAL PROFILES FROM CALIOP AND GROUND-BASED LIDAR IN BELGRADE, SERBIA

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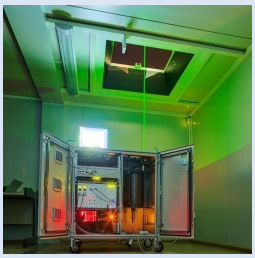
Introduction

The atmospheric aerosols play an important role in climate and air pollution processes. Diversity of their sources and thus their properties makes it challenging to quantify their effects and represent them realistically in weather and climate models. Monitoring temporal and spatial variability of aerosol optical properties is crucial to assess aerosol effect on Earth's radiative balance and in studies of aerosol-cloud interaction. Besides, information on temporal evolution of the vertical extent of aerosol layers is important for analyzing particulate air pollution and differentiation between contributions of long-range transported and locally-emitted aerosols. Aerosol lidars provide data on vertical profile of aerosol optical properties - backscatter and extinction coefficients. While ground-based lidars trace the temporal changes of these vertical profiles, satellite-based lidars provide a global picture of aerosol vertical distribution.

In this study we present examples of comparison of ground-based lidar in Belgrade and CALIOP measurements onboard CALIPSO satellite. This region is known for elevated air pollution levels, and very limited ground-based aerosol measurements.

Lidar measurements in Belgrade



- a pulsed Nd:YAG laser: 1064 nm, 532 nm and **355 nm**
- signal detection at 355 and 387 nm
- temporal resolution 1 min
- vertical resolution 7.5 m

- In this work **elastically backscattered signal at 355 nm is analyzed**
- The aerosol backscatter coefficient is derived from lidar signals averaged over 30-min intervals using Klett-Fernald retrieval method (Klett, 1981; Fernald, 1984), **assuming lidar ratio value of 50 sr.**

CALIOP data

- Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) operated aboard CALIPSO satellite
- performed elastic backscatter measurements at **532 nm** and **1064 nm**, and linear depolarization measurements at 532 nm
- We use aerosol backscatter coefficient data from the CALIPSO 5-km Aerosol Profile product (Level 2, Version 4.51) and information on aerosol types.
- The products are reported with horizontal resolution of 5 km and vertical resolution of 60 m in the troposphere.
- In this work we use cloud-free profiles and apply QA criteria described in Tackett et al. (2018)
- Color ratio (CR) is calculated as ratio of vertically integrated backscatter coefficients at 532 nm and 1064 nm, for comparison with values from Groß et al. (2013) for different aerosol types.
- **the analysis is limited to a qualitative comparison due to different wavelengths of Belgrade ground-based lidar (355 nm) and CALIOP (532 nm and 1064 nm) measurements.**

Acknowledgements

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References

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Groß, S., M. Esselborn, B. Weinzierl, et al. (2013). Aerosol classification by airborne high spectral resolution lidar observations. *Atmos. Chem. Phys.*, 12, 25983.

Klett, J. D. (1981). Stable analytical inversion solution for processing lidar returns. *Appl. Opt.*, 20(2), 211.

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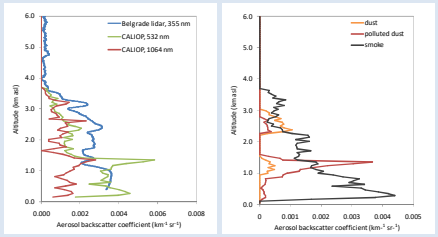
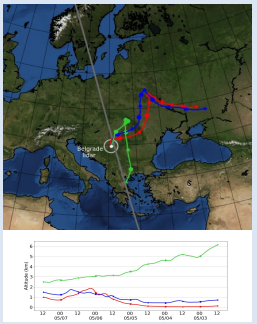
Tackett, J. L., Winker, D. M., Getzewich, B. J., et al. (2018). CALIPSO lidar level 3 aerosol profile product: version 3 algorithm design. Atmos. Meas. Tech., 11, 4129.

Results

Case of May 7, 2018



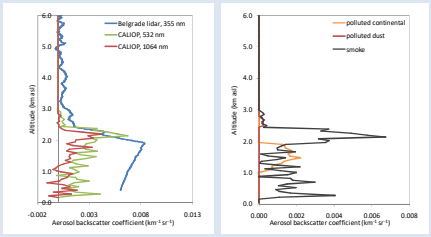


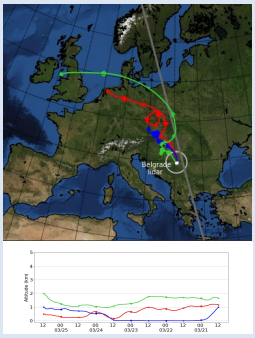
- CALIOP vertical profiles of backscatter coefficient at distances of 47.4 – 100 km from ground-based lidar were averaged

CR values - CALIOP
- boundary layer (smoke): 2.5
- elevated layer (smoke + dust + polluted dust): 1.3

CR values - Groß et al. (2013)
- anthropogenic pollution : 2.43 ± 0.27
- Saharan dust : 1.30 ± 0.15

Case of March 25, 2019



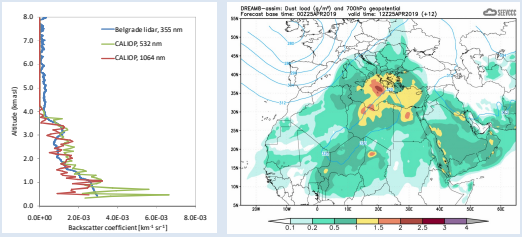


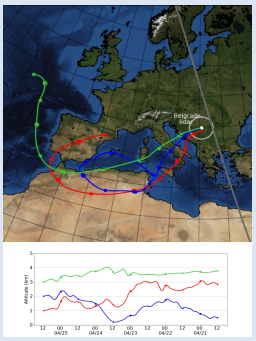
- CALIOP vertical profiles of backscatter coefficient at distances of 96.5 – 150 km from ground-based lidar were averaged

CR value – CALIOP
smoke + polluted continental: 2.5

CR values - Groß et al. (2013)
anthropogenic pollution: 2.43 ± 0.27

Case of April 25, 2019



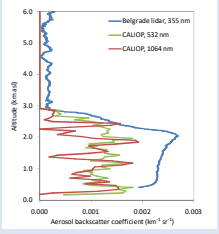


- CALIOP vertical profiles of backscatter coefficient at distances of 180.6 – 200 km from ground-based lidar were averaged

CR value – CALIOP
dust: 1.5

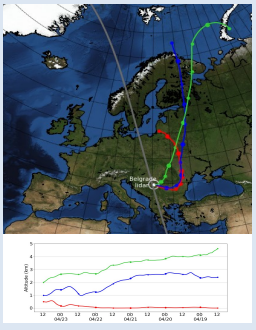
CR values - Groß et al. (2013)
- Saharan dust : 1.30 ± 0.15
- mixed Saharan dust : 1.48 ± 0.09

Case of April 23, 2020



CR values – CALIOP
polluted dust: 1.3

CR values - Groß et al. (2013)
- Saharan dust : 1.30 ± 0.15
- mixed Saharan dust : 1.48 ± 0.09



- CALIOP vertical profiles of backscatter coefficient at distances of 27.1 – 100 km from ground-based lidar were averaged

Conclusion

- A qualitative comparison of aerosol backscatter coefficients from ground-based lidar measurements in Belgrade and CALIOP data, is carried out for cases with different airmass origins.
- Vertical profiles of aerosol backscatter coefficient from CALIOP and Belgrade lidar show agreement in extent and vertical structure of aerosol layer.
- While CALIOP aerosol type classification, along with airmass backward trajectories, provide valuable information, aerosol models are necessary to support interpretation of measured aerosol vertical profiles.