**DRONE-BASED VERTICAL MEASUREMENTS OF BLACK CARBON AEROSOLS AT A RURAL BACKGROUND AND AN URBAN SITE**

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# DRONE-BASED VERTICAL MEASUREMENTS OF BLACK CARBON AEROSOLS AT A RURAL BACKGROUND AND AN URBAN SITE

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## INTRODUCTION

Black Carbon (BC) aerosols are primary particles emitted into the atmosphere as a by-product of incomplete combustion processes. BC absorbs solar radiation and alters the radiation budget of the Earth(Bond et al., 2013). The radiative properties of BC heavily depend on its vertical profiles(Haywood and Ramaswamy, 1998). For example, BC in the free troposphere can enhance its radiative forcing by trapping energy emitted from lower cloud layers.

The modeling-based studies on BC vertical distribution are particularly poor (Chen et al., 2022), creating a need to measure the vertical distribution of BC on a regional scale, from areas characterized by anthropogenic emissions from the ground to those characterized by long-range transport(Ramana et al., 2010). Among all the other methods, drones have recently gained popularity because of their high-cost efficiency, flexibility, and mobility. Besides comparing BC aerosol vertical distribution at an urban and a regional background site, this study also calibrates drone measurements using a 230-meter tower.

## EXPERIMENTAL SETUP

This study aims to measure the vertical profile of BC aerosols using a drone at two locations: 1. NAOK (National Atmospheric Observatory Košetice), which represents a regional background site, and 2. MFF (Faculty of Mathematics and Physics in Prague), which represents an urban location. At NAOK, a 250-meter measurement tower is also available, serving as a way to calibrate the drone measurements. Aethalometer AE33 (Aerosol Magee Scientific) is operating on the ground as well as on top of the tower.

Two instruments have been deployed on the drone (DJI Mavic 3). The micro-Aethalometer AE51 (AethLabs San Francisco, CA) provides real-time equivalent BC (eBC) concentration, while meteorological data (temperature and relative humidity) were sampled using a COMET data logger. The measurement interval is ten seconds to cover the high temporal variability of eBC concentrations at the polluted site and to cover changes in height during the flight. During the flights, the drone climbed vertically from the ground to 230 m and 100m AGL at a constant speed of 1 m $s^{-1}$ along the tower at NAOK and the MFF building, respectively. The drone hovered at different heights for at least 5 minutes and then ascended in the same vertical direction at the same speed. The descended flights were not considered due to the propellers' effect on aerosols' flow. All inlets of the instruments were placed 30 cm above the drone to minimize the downwash effect (Villa et al., 2016).

## RESULTS AND CONCLUSIONS

Vertical profiles of black carbon aerosols were measured from July 31 - Aug 4, 2023 at NAOK and Aug 14 - Aug 20, 2023 at MFF. The weather conditions during the campaigns were rainy and gusty at NAOK, while at MFF temperatures were high. The vertical profile exhibits very little change from 4m to 100m at MFF, suggesting a well-mixed layer, while a slight concentration decrease above 100m elevation can be observed at NAOK (Fig. 1). The comparison of eBC concentrations from micro-Aethalometer AE51 on the drone and Aethalometer AE33 at the top of the tower (230m) can also be seen, establishing the comparability of the data.

The morning, noon, and evening profiles were also computed for both sites. The morning profiles were found to be the highest at both sites, while afternoon profiles were higher compared to the evening profiles at MFF due to traffic emissions (people leaving early from the office during the summertime).

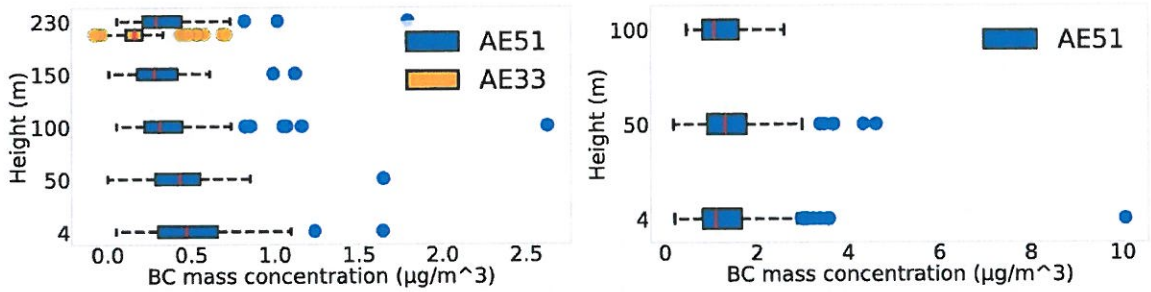


Fig. 1: Left: boxplot of eBC concentration from AE51 on the drone and from the reference device AE33 on the NAOK tower, right: boxplot of eBC concentration from AE51 on the drone at MFF.

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