

Abstract

Absorbing aerosols belong to an important group of atmospheric aerosols. They affect Earth's climate in a complex way, hence their influence is difficult to assess. Moreover, those aerosols play a vital role in physical processes connected with smog emissions. The main difficulty in the analysis of their impact on climate and smog conditions is very limited measurement data, especially as far as profiles of vertical distribution of absorbing aerosols are concerned. The aim of this work is to establish and verify a method that would enable to measure vertical profiles of absorption coefficient and concentration of absorbing aerosols with the usage of unmanned aerial vehicles (drones) as platforms for miniature atmospheric sensors. The data acquired in this way can be used to model radiation streams, assess how smog conditions develop and diminish, or to make atmospheric correction for remote sensing devices. Basing on the synergy of profiles of absorption coefficient with those of extinction coefficient, measured by lidar systems, we can establish vertical profiles of single scattering albedo.

It was decided that the optimal method for probing would be profiling with multi-rotor drone, with attached micro-aethalometer and meteorological radiosonde. This method is highly efficient for conducting any observation (high level of repetitiveness, easy preparation, high temporal and spatial resolution) on low budget. In the years 2013-2015, the method was tested during field experiments in Strzyzow, Swider and Warsaw for probing aerosols in various conditions and using data from different lidar systems, which allow to apply multiple inversion methods. The results, scoping absorbing aerosols optical depth and single scattering albedo, were then compared with data from the AERONET photometric network and in situ measurements on ground level. As the compatibility of AERONET data with other measurement was relatively low, it was proposed to assess absorbing aerosols optical depth on the basis of the synergy of measurements conducted with the use of drones and lidars and on-ground in situ measurements. In the course of the research, it was proved that the quality of AERONET data for optical properties of absorbing aerosols, especially in low aerosol optical depth conditions, is rather questionable.

In order to assess how changing vertical profile of single scattering albedo affects

direct radiative forcing, streams of short-wave diffused radiation reaching the top of atmosphere and surface of the Earth, and profiles of radiative heating, we conducted simulations on the numeric radiative transfer model. The differences observed in the streams of diffused radiation were low, as they did not exceed 3% ,regardless of the zenith angle of the sun, which changed the radiative forcing to below 10%. The greatest changes, up to 3K, were noted for radiative heating. Depending on the profile, the influence on atmospheric correction for vegetation index reached up to 7.7%, with the ratio exceeding 20% for snow albedo.