# BOUNDARY-LAYER HEIGHT BY CEILOMETER AND RADIOSOUNDING IN SOFIA VALLEY FOR SPECIFIC CASES

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## ABSTRACT

*Sofia is the biggest city in Bulgaria and it is located in a valley elevated 550 – 600 m asl, surrounded completely by mountains with different height. In this situation, the profiles of meteorological parameters differ from those above flat homogeneous terrain. The valley is characterized by local circulations, the effect of which on vertical profiles is not studied in detail. In particular, the determination of the boundary-layer height (BLH) is challenging task due to multiple inversion layers often observed in radiosounding records. Every winter, the valley suffers from persistent strong fogs during anticyclonic situations and the observation of BLH with ceilometer is quite challenging. Therefore, in this study, two types of instruments are used – radiosounding and ceilometer. The aerological sounding is launched in the eastern part of the city at Sofia aerological observatory (WMO 15614) at 12h UTC. The ceilometer of Sofia University is positioned near the city centre in a park. Two main cases are analyzed: persistent fog over the valley in winter and convective almost cloudless situations during summer. Two periods of about 10-15 days duration were chosen for the study, covering winter of 2015 and summer of 2013. During hot cloudless days the BLH determined by ceilometer and radiosoundings is similar. During foggy periods, the direct method of radiosounding provides profiles and information about the vertical extend of the foggy layer. The ceilometer signal does not penetrate through the fog, but the high resolution of the ceilometer observations allows to identify start, duration and end of persistent fog situations. The measured profiles of both periods and methods are compared with MM5 mesoscale model forecasts at noon.*

## Location and BLH experimental data and methods

The BLH has prime significance for the interaction between the Earth surface and the atmosphere and gives important knowledge for the climate, weather prediction and air pollutants concentration.

In this study the BLH from the aerological data the potential temperature, and the other profiles of the gradients of the wind speed and direction and the relative humidity are used with combination.

The BLH from the ceilometer is calculated using the STRAT software package for the signal selection and computation.

The BLH from the MM5 mesoscale model is made with restoration of the profiles from the lowest levels data.

*Figure 1. Location of city of Sofia in Bulgaria. The capital is entirely surrounded by mountains with altitude of around 1400m ~ 2300m asl*

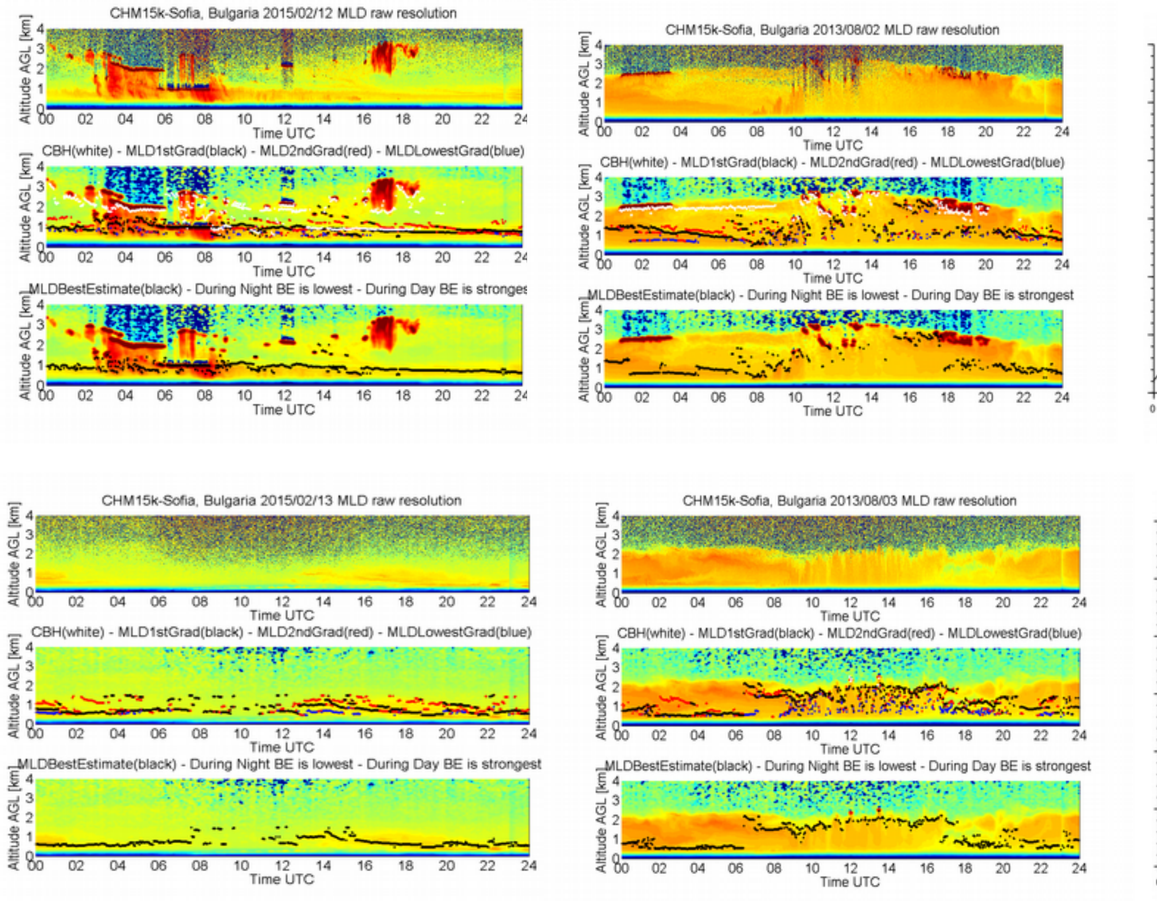
### Experimental

-The aerological sounding is performed daily at 12:00 UTC with high vertical resolution of 5-6m by MW41 Vaisala MW41 sounding system by the Central Aerological Observatory (CAO) WMO 15614 for 2015 and the second half of 2013. It is located in the eastern part of the city. For 2013 the data is from MW21 with lower resolution – 10-12m. The analyzed soundings are 588-3000m a.s.l. height so that the BLH is in the researched levels.

-The ceiliometer system Lufft CHM15K is located nearly in the center of the city and the valley of Sofia in the central park. The measurements are made during all the day and night period.

## Measurements

The results from the measurements showed the ceiliometer can not be used in foggy days. There were no reliable data from foggy days and in that cases the upper-air sounding is the only way to get information for the profiles of meteorological elements. In consequences, cloudless days during both seasons were chosen.



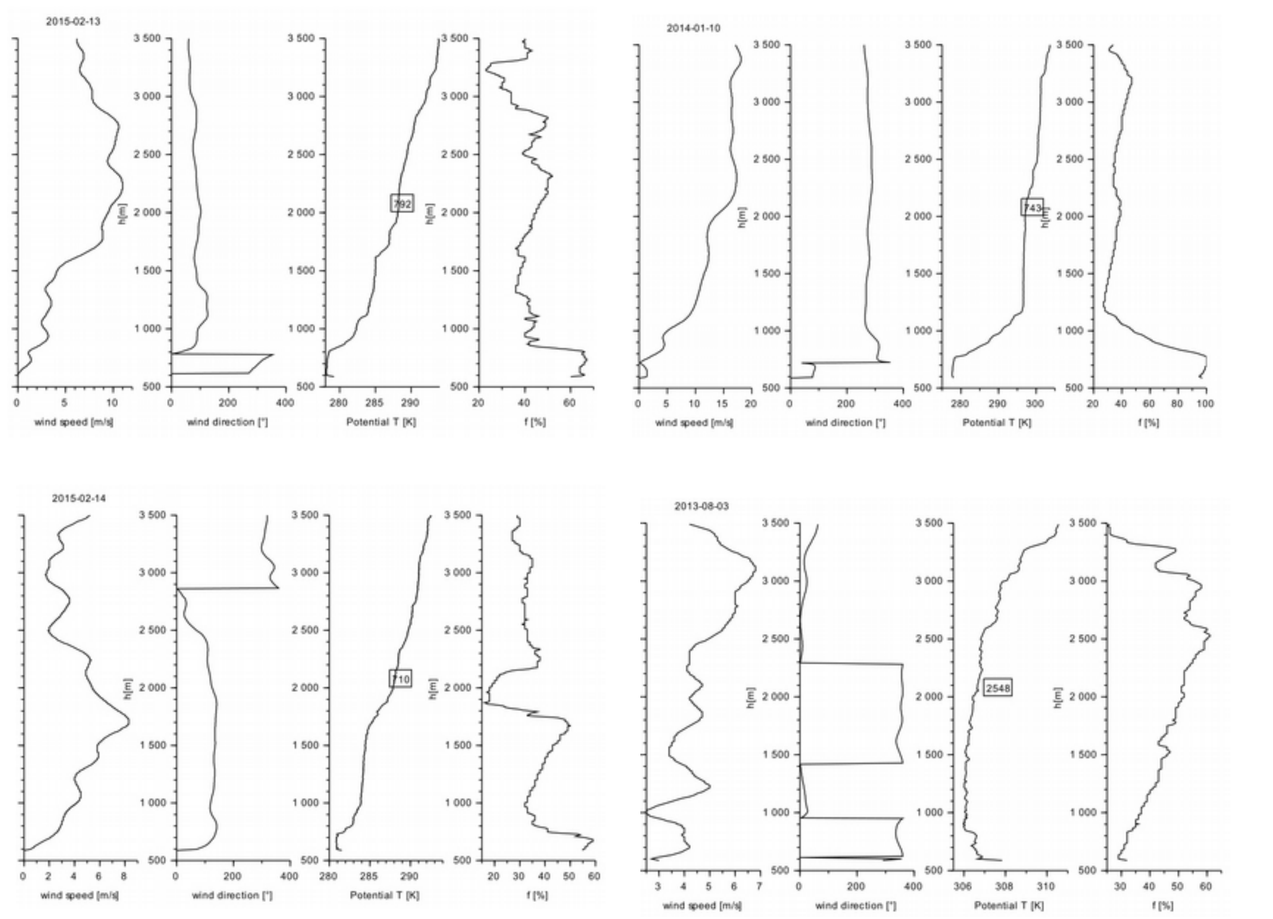




*Figure 2. The data from the ceilometer for the winter (left) and the summer (right) in almost cloudless days.*

*Figure 3. The data from the aerological soundings in the same days as ceilometer (left and right dawn) and from a foggy day in the Sofia valley*

## Results

The ceilometer works very well and is with good correlation with the data from the aerological soundings in cloudless days in Sofia valley, regardless the season. For the noon time these two methods can be used for completing each other and checking system in doubtful cases and meteorological elements profiles.

## MM5 data and the measurements

The configuration of MM5 mesoscale forecast model, used in this study contains 14 levels from 35 m above ground to 12 000 m above ground. The first 10 levels are nearly 2300 m above the ground which gives possibility for relatively proper restoration of the meteorological elements` vertical profiles. In the analyzed periods the correlation between the measurements and the data from the model is comparable mostly in the lower heights of Boundary layers, especially in the winter. In cases of higher then 2000 m above the ground BLH the less frequent levels of the model increases the difference.

## SUMMARY

The measurements from the ceilometer and the upper-air soundings are comparable in the cases of cloudless days or with small could coverage at noon regardless the season in Sofia valley. To be able to use the data from the ceilometer for whole the day and night period additional soundings during the night are needed to prove the correlation between the two systems.

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