



## Investigating long-term variations in cloud base height over Sofia, Bulgaria

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Clouds have a key role in weather and climate forecasting due to their effect on global radiation and water budget. Clouds change the radiation energy in the Earth-atmosphere system by reducing both incoming and outgoing parts, depending on their macro- and microphysical characteristics such as cloud base height (CBH), optical properties etc. These clouds properties are generally related to cloud types, so the effects in weather and climate caused by various cloud types differ greatly. It is known that high clouds cause the earth's surface to heat up, while low clouds cause cooling. Obviously, cloud radiation forcing is an important source of uncertainty in the numerical weather and climate models, so the registered and expected changes in the properties of clouds due to a warming climate need in-depth studies. But cloud base height is not only important for weather and climate forecasting, but also for airplane traffic safety. Nowadays, retrieving the CBH is mainly based on satellite and ground-based observations. Satellite-borne instruments provide tempting spatial coverage but uncertainty in CBH estimation should be considered. In contrast, many ground-based observations of the CBH are characterized by higher accuracy. Nowadays, ceilometers - lidars specifically designed to detect CBH, that operate continuously and unattended, providing high vertical and time-resolution data, are reference instrument in CBH measurement. In addition, rawinsondes provide in-situ measurements of temperature, humidity, and pressure, so that the CBH can be evaluated by the lifting condensation level or by threshold value in relative humidity. In areas where only surface measurements are available, a simple adiabatic model of a rising air parcel can be applied in the CBH assessment. In this work, based on ceilometer, rawinsonde and surface measurements, the characteristics of CBH over Sofia, Bulgaria are studied in detail. We start with an intercomparison between CBHs obtained from three types of ground-based observations, considering the individual advantages and disadvantages of the methods by using ceilometer as reference. Finally, the daily, seasonal and interannual variability of CBH over Sofia are interpreted.