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Efforts to develop a quantitative definition of cloud base height for aviation

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Ceilometers are valuable measuring instruments for determining cloud base height (CBH) from the attenuated lidar backscatter signal. Due to the application of manufacturer-specific algorithms and lack of a generally accepted definition various types of collocated ceilometers (e.g. CL31 from Vaisala, CHM15k from LUFFT, CS135 from Campbell) derive different CBH values for the same cloud situation. Very low clouds with CBHs up to 1500 ft (about 460 m) above ground level are particularly important for coordinating the air emergency and air traffic in general, but results from ceilometers are relatively uncertain in this altitude range. In the framework of the AutoMETAR project initiated by Deutscher Wetterdienst (DWD) and in collaboration with Universität Hamburg the 300 m high "Hamburg Weather Mast" was therefore used to identify a possible definition of CBH for aviation purposes based on image analysis. For the 1st phase of the so-called CircaHH campaign (October 2016 to April 2017) a Sony Alpha 7 camera was set up 178 m away from the Hamburg Weather Mast. Since the latter is increasingly obscured from the top downwards if the CBH descends, the contrast ratio of its alternating red and white segments has been used to calculate the vertical profile of the extinction coefficient. A number of different methods were analyzed for their ability and effectiveness to derive CBH from these extinction profiles. Here, the slant optical range (SOR) was found to be the most suitable quantity, where the CBHs calculated by use of a SOR threshold of 1000 m showed the best agreement to those estimated visually as well as provided by the ceilometer type LD40 from Vaisala, which is used currently at German international airports. In preparation for the 2nd phase of CircaHH two horizontal visibility sensors (PWD20) have been installed in 175 m and 280 m altitude. Based on their measurements that started in mid-March 2018 the plausibility and reliability of the extinction profile derived from the photographs will be explicitly verified. Although it is ongoing work the SOR approximation seems to be a suitable reference method for evaluating the CBH delivered by various ceilometer types. Our preliminary and unique results reveal that the SOR with a threshold of 1000 m is an adequate quantitative definition of CBH, which will also be applied to the extinction profile derived directly from the backscatter signal of a respective ceilometer.