How many Cirrus clouds do we overlook when observing from the Earth surface?

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One of the greatest advantage of the space lidar is the ability to collect reliable data on high (Cirrus) clouds. Traditionally, statistics on cloud frequency at different levels of the atmosphere have been computed using surface-based observations (SYNOPs). This non-instrumental method solely relies on human vision. Due to its simplicity, the visual method has been used since the 19th century and therefore provides the longest (thus valuable) climatological time series. However, numerous studies highlight that SYNOP data related to high-level cloud are unreliable, as clouds at that level cannot be observed when the sky is partially or completely obscured by cloud at lower levels. Given that high-level clouds have a positive radiative forcing in the atmosphere, it is very important to estimate the reliability of surface-based observations of Cirrus clouds. We achieve that goal using state-of-the-art CALIPSO lidar profiles (CAL_LID_L2_01kmCLay-Standard-V4-10 product) as a reference. We have collocated 865,445 individual SYNOP observations worldwide with CALIPSO overpasses between 2007-2017. 30% of those observations satisfied the requirement of not more than 10-minute difference in time, and not more than 40-km difference in space. For each matchup we reported the presence of Cirrus according to SYNOP and CALIPSO. Based on that we have calculated three main measures of SYNOP's reliability: 1. the overall accuracy of Cirrus cloud detection, 2. the probability of false alarm (FAR), and 3. the probability of Cirrus detection (POD). Results are reported separately for ideal conditions (no mid- or/and low-level clouds), and true conditions (clouds occur at each level). Such approach reveals the actual sensitivity of visual observations, as well as SYNOPs' limitations due to clouds overlap. Since CALIPSO lidar is a profiling instrument with pencil-like laser beam, and SYNOPs report clouds over 20-50 km around a station, we correct the results for that inconsistency. The correction bases on MODIS data and ISCCP definition of high clouds. The study was founded by National Science of Poland under the contract no. UMO-2017/25/B/ST10/01787.