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Validation of manual, surface-based detections of Cirrus with CALIPSO space lidar

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Clouds generally cool the atmosphere due to a negative net radiative forcing. However the Cirrus clouds warm the climate, despite they co-occur with other cloud types, or are the only cloud layer present. Consequently, changes in Cirrus frequency are important for understanding the climate change and climate variations. Manual, ground-based observations of Cirrus are the longest climate record on that variable. The reliability of those observations is questionable, because of viewing geometry (middle/low-level clouds obscure the high-level clouds), and observers ability to detect optically thin media in the upper atmosphere.

We have validated the reliability of ground-based observations of Cirrus using state-of-the-art lidar data from the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission. Focusing on the observer's sensitivity to Cirrus, we only evaluated the observations under a perfect conditions: no clouds at middle/low level. We found that probability of Cirrus detection was 67% during the day time, and was controlled by the Cirrus optical depth (60% for subvisual clouds, and >95% for depth >5). During the night the probability of detection decreased to 35%. Presence of the illuminated Moon positively impacted the hit rate, but only when lunar phase was greater than 50%. Evaluation of the visual method, as a whole, considered clouds at any level, as they occur in real, true-weather conditions. We found that probability of Cirrus detection was 48% daytime, and as little as 28% nighttime. The increase of the sky sealing by low/middle-level clouds negatively impacted the accuracy. Sharp decrease in Cirrus detection efficiency was observed when cloud fraction for middle/low clouds exceeded 50%-60% (daytime), and 10%-25% (nighttime).

Based on the results, we conclude that in the majority of cases, accuracy we found can be achieved just by an accident: "Cirrus"/"no Cirrus" can be reported with no looking at the sky, and the resulting accuracy will be the same as for the real, empirical data from stations. Consequently, the manual observations are highly uncertain and may be unreliable for deriving a long-term climate trends. Even at best, the surface-based, manual observations are less reliable than those collected with a satellite imagers (specifically the MODIS-VIIRS cloud product).