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Barbados Cloud Observatory: The detection of weak Radar reflectivity signals below shallow cumulus clouds

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The Barbados Cloud Observatory (BCO) is located on the east coast of the island of Barbados (13° 09' N, 59° 25' W), where it is exposed to the relatively undisturbed easterly trade winds. The position of the BCO is well suited for studies of shallow cumulus clouds, which have a significant impact on Earth's radiation budget and on the energy and water cycles. In the presented study, measurements from a K-band cloud radar, with an exceptional sensitivity, and a ceilometer are used to analyze the lower environment of shallow cumulus clouds. Below their nominal base, which is well defined by the determination of the lifting condensation level and the ceilometer measurements, the cloud radar detects a weak reflectivity signal. This signal is observable down to 250 m below the cloud base and shows an intensity between -50 dBZ and -65 dBZ. Artifacts, caused by the radar instrument itself (e.g. Bragg-Scattering) or by objects other than hydrometeors, cannot produce this weak reflectivity signal. We suggest that small raindrops (400 µm diameter or larger) develop inside the upper part of the cloud and fall into the region below the cloud, where they cause the weak radar reflectivity signal. These drops must have a very low number concentration (1 drop/100 m^3) since they are not visible to the human eye. Radiosonde data and satellite images indicate that the occurrence of the weak radar reflectivity signal is connected to the humidity conditions in higher altitudes (up to 2500 m). A high relative humidity at this altitude allows for a larger vertical extension of a cloud and thus makes it easier for raindrops to develop inside the cloud and then fall below cloud base. This phenomenon is interesting, because the appearance of droplets with a low number concentration below shallow cumulus clouds could be a precursor of surface precipitation.