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Quantifying the contribution of different cloud types to the radiation budget in southern West Africa

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The contribution of cloud to the radiation budget of southern West Africa (SWA) is poorly understood yet is important for understanding regional monsoon evolution and for evaluating and improving climate models, which have large biases in this region. Radiative transfer calculations applied to atmospheric profiles obtained from the CERES-CloudSat-CALIPSO-MODIS (CCCM) dataset are used to investigate the effects of 12 different cloud types (defined by their vertical structure) on the regional energy budget of SWA (5–10 °N, 8 °W-8 °E) during June-September. We show that the large regional mean cloud radiative effect in SWA is due to non-negligible contributions from many different cloud types; 8 cloud types have a cloud fraction larger than 5 % and contribute at least 5 % of the regional mean shortwave cloud radiative effect at the top of atmosphere. Low-clouds, which are poorly observed by passive satellite measurements, were found to cause net radiative cooling of the atmosphere, which reduces the heating from other cloud types by approximately 10 %. The sensitivity of the radiation budget to underestimating low-cloud cover is also investigated. The radiative effect of missing low-cloud is found to be up to approximately –25 W m-2 for upwelling shortwave irradiance at the top of atmosphere and 35 W m-2 for downwelling shortwave irradiance at the surface.