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A multisatellite climatology of clouds, radiation, and precipitation in southern West Africa and comparison to climate models

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Southern West Africa (SWA) has a large population that relies on highly variable monsoon rainfall, yet climate models show little consensus over projected precipitation in this region. Understanding of the current and future climate of SWA is further complicated by rapidly increasing anthropogenic emissions and a lack of surface observations. Using multiple satellite observations, the ERA-Interim reanalysis, and four climate models, we document the climatology of cloud, precipitation, and radiation over SWA in June–July, highlight discrepancies among satellite products, and identify shortcomings in climate models and ERA-Interim. Large differences exist between monthly mean cloud cover estimates from satellites, which range from 68 to 94%. In contrast, differences among satellite observations in top of atmosphere outgoing radiation and surface precipitation are smaller, with monthly means of about 230 W m−2 of longwave radiation, 145 W m−2 of shortwave radiation, and 5.87 mm d^{-1} of precipitation. Both ERA-Interim and the climate models show less total cloud cover than observations, mainly due to underestimating low cloud cover. Errors in cloud cover, along with uncertainty in surface albedo, lead to a large spread of outgoing shortwave radiation. Both ERA-Interim and the climate models also show signs of convection developing too early in the diurnal cycle, with associated errors in the diurnal cycles of precipitation and outgoing longwave radiation. Clouds, radiation, and precipitation are linked in an analysis of the regional energy budget, which shows that interannual variability of precipitation and dry static energy divergence are strongly linked.