A 10-year climatology of cloud fraction and vertical distribution derived from both surface and GOES observations over the DOE ARM SGP site

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Abstract
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Analysis of one decade of radar-lidar and Geostationary Operational Environmental Satellite (GOES) observations at the Atmospheric Radiation Measurement (ARM) Program Southern Great Plains (SGP) site reveals that there is excellent agreement in the long-term mean cloud fractions (CF) derived from the surface and GOES data, and the CF is independent of temporal resolution and spatial scales for grid boxes of size 0.5o to 2.5°. When computed over a 0.5-hr (4-hr) period, cloud frequency of occurrence (FREQ) and amount when present (AWP) derived from the point surface data agree very well with the same quantities determined from GOES for a 0.5o (2.5o) region centered on the ARM SGP site. The values of FREQ (AWP) derived from the radar-lidar observations at a given altitude increase (decrease) as the averaging period increases from 5 min to 6 hours. Similarly, CF at a given altitude increases as the vertical resolution increases from 90 to 1000 m. The profiles of CF have distinct bimodal vertical distributions with a lower peak between 1 and 2 km and a higher one between 8 and 11 km. The 10-year mean total CF, 46.9%, varies seasonally from a summer minimum of 39.8% to a maximum of 54.6% during the winter. The annual mean CF is 1-2% less than that from previous studies, ~48-49%, because fewer clouds occurred during 2005 and 2006, especially during winter. The differences in single- and multi-layered CFs between this study and an earlier analysis can be explained by the different temporal resolutions used in the two studies where single-layered CFs decrease but multilayered CFs increase from a 5-min resolution to a 1-hr resolution. The vertical distribution of nighttime GOES high-cloud tops agrees well with surface observations, but during daytime, fewer high clouds are retrieved by the GOES analysis than seen from the surface observations. The frequencies of occurrence for both daytime and nighttime GOES low-cloud tops are significantly higher than surface observations, but the cloud fractions are in good agreement.