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A radiation closure study of Arctic stratus cloud microphysical properties using the collocated satellite-surface data and Fu-Liou radiative transfer model

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Retrievals of cloud microphysical properties based on passive satellite imagery are especially difficult over snow-covered surfaces because of the bright and cold surface. To help quantify their uncertainties, single-layered overcast liquid-phase Arctic stratus cloud microphysical properties retrieved by using the Clouds and the Earth's Radiant Energy System Edition 2 and Edition 4 (CERES Ed2 and Ed4)algorithms are compared with ground-based retrievals at the Atmospheric Radiation Measurement North Slope of Alaska (ARM NSA) site at Barrow, AK, during the period from March 2000 to December 2006. A total of 206 and 140 snow-free cases (Rsfc $\leq$ 0.3), and 108 and 106 snow cases (Rsfc>0.3), respectively, were
selected from Terra and Aqua satellite passes over the ARM NSA site. The CERES Ed4 and Ed2 optical depth (τ)and liquid water path (LWP) retrievals from both Terra and Aqua are almost identical and have excellent agreement with ARM retrievals under snow-free and snow conditions. In order to reach a radiation closure study for both the surface and top of atmosphere (TOA) radiation budgets, the ARM precision spectral pyranometer-measured surface albedos were adjusted (63.6% and 80% of the ARM surface albedos for snow-free and snow cases, respectively) to account for the water and land components of the domain of 30 km $\times$ 30 km. Most of the radiative transfer model calculated SW$\downarrow$sfc and SW$\uparrow$TOA fluxes by using ARM and CERES cloud retrievals and the domain mean albedos as input agree with the ARM and CERES flux observations within 10Wm2 for both snow-free and snow conditions. Sensitivity studies show that theARM LWP and re retrievals are less dependent on solar zenith angle (SZA), but all retrieved optical depths increase with SZA.