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A 10-yr Climatology of Arctic Cloud Fraction and Radiative Forcing at Barrow, Alaska

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A 10-yr record of Arctic cloud fraction and radiative forcing has been generated using data collected at the Atmospheric Radiation Measurement (ARM) North Slope of Alaska (NSA) site and the nearby NOAA Barrow Observatory (BRW) from June 1998 to May 2008. The cloud fractions (CF) derived from ARM radar-lidar and ceilometer measurements increase significantly from March to May (0.57→0.84), remain relatively high (∼0.80-0.9) from May to October, and then decrease from November to the following March (0.8→0.57), having an annual average of 0.76. These CFs are comparable to those derived from ground-based radar-lidar observations during the SHEBA experiment and from satellite observations over the Western Arctic regions. The monthly means of estimated clear-sky and measured all-sky SW-down and LW-down fluxes at the two facilities are almost identical with the annual mean differences less than 1.6 Wm^{-2}. Values of LW CRF are minimum (6 Wm^{-2}) in March, then increase monotonically to reach maximum (63 Wm^{-2}) in August, then decrease continuously to the following March. The cycle of SW CRF mirrors its LW counterpart with the greatest negative impact occurring during the snow free months of July and August. On annual average, the negative SW CRFs and positive LW CRFs nearly cancel, resulting in annual average NET CRF of about 3.5 Wm^{-2} on the basis of the combined ARM and BRW analysis. Compared with other studies, we find that LW CRF does not change over the Arctic regions significantly, but NET CRFs change from negative to positive from Alaska to the Beaufort Sea, indicating that Barrow is at a critical latitude for neutral NET CRF. The sensitivity study has shown that LW CRFs increase with increasing cloud fraction, liquid water path, and radiating temperature with high positive correlations (0.8-0.9). Negative correlations are found for SW CRFs but a strong positive correlation between SW CRF and surface albedo exists.