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Observed cirrus cloud radiative forcing on surface-level shortwave and longwave irradiances

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The radiative effects of high altitude clouds on the surface energy budget, in both the solar and infrared spectrum, are well known but not well quantified. Precise quantification of radiative effects of clouds requires precise reference solar and infrared irradiance values for the cloud free atmosphere. Such reference values are obtained by two parametric representations that use ground-based surface and integrated information on temperature, water vapor and aerosols to estimate clear-sky values of solar and infrared irradiances with root mean square error below 5 W m^{-2}.Clear-sky model calculations are evaluated against measurements for cloud free conditions determined by combined analysis of lidar and broadband flux measurements. We analyze solar and infrared irradiance measurements, cloud and aerosol Lidar backscattering profiles, microwave radiometer brightness temperatures, radiosonde profiles, and sunphotometer extinctions gathered on three sites, SIRTA Observatory (48˚42'N, 2˚12' E), ARM SGP Lamont (36˚36'N, -97˚29' E) and ARM TWP Darwin (12˚25'N, 130˚53' E) to estimate the Cirrus cloud Radiative Forcing (cloud base above 7 km) on surface-level shortwave (CRF_{SW}) and longwave (CRF_{LW}) irradiances. The sensitivity of CRF_{SW} to Cloud Optical Thickness (noted CRF_{SW}*) ranges from 100 W m^{-2} to 400 W m^{-2}per unit of cloud optical thickness depending on cloud regime. The combined influence of aerosol optical thickness and integrated water vapor on CRFSW* is quantified (10 to 20 % CRF_{SW}* range) for turbid and pristine atmosphere. Moreover, the sensitivity of the CRFLW to both cloud emissivity and cloud temperature (noted

CRFLW*) is established and the influence of integrated water vapor on CRFLW* is quantified (30 to 50 % CRF_{LW}* range) for wet and dry atmosphere.