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Surface radiation budget derived from CERES data and its variability

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Monthly mean surface irradiances are computed using atmospheric properties from reanalysis (GEOS4 and 5) and cloud properties derived from MODIS. The surface irradiances are based on a CERES level 3 product, SYN1deg. Further adjustments are made to monthly 1 degree by 1 degree gridded mean irradiances based on the difference between modeled and CERES derived top-of-atmosphere irradiances, temperature and humidity profiles from GEOS4 and 5 and AIRS-derived profiles, and MODIS and CALIPSO-, CloudSat-derived cloud properties. The resulting surface irradiances are, therefore, consistent with multiple-satellite observations, including CERES, MODIS, AIRS, CALIPSO, and CloudSat, to within a framework of 1D radiative transfer theory. Ten years of data from March 2000 through February 2010 are processed. The global annual mean net surface irradiance is 108 Wm-2 with the standard deviation of 0.6 Wm-2. The estimated uncertainty of the surface net irradiance (one sigma) is 12 Wm-2. The standard deviation of deseasonalized anomalies of surface net irradiance is 0.4 Wm-2. The standard deviation of deseasonalized downward surface shortwave and longwave irradiances are 0.7 Wm-2 and 0.6 Wm-2, respectively.

At regional scales (e.g. tropics, midlatitudes, and polar regions), the variability in net TOA and surface shortwave irradiances are highly correlated, but the correlation with net atmospheric shortwave irradiance is poor. This is consistent with an earlier study showing that cloud fraction variability is the major cause of TOA shortwave irradiance variability. Therefore, the variability of energy input to the earth directly affects surface radiation budget. In contrast, the variability in regioanal TOA longwave irradiance is poorly correlated with the variability in both atmospheric and surface net longwave irradiances. Therefore, there is no dominant surface or atmospheric property that affects TOA, surface and atmospheric longwave irradiances. Rather, longwave irradiance variability is a result of complex variability in surface and atmospheric properties. To investigate the relationship between large scale dynamics and surface net irradiance anomalies, the correlation between the time series of surface net irradiacne anomalies and ENSO index, as well as the spatial distribution of surface temperature anomalies versus atmospheric net irradiance anomalies are analyzed. In addition, the variability of global mean surface net irradiances and precipitation variability from Global Precipitation Climatology Project (GPCP) are compared.