IRS2012-98
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012

A semi-empirical model for estimating surface solar radiation from satellite data

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Information on solar radiation at the earth's surface is of importance for atmospheric research and solar energy applications. As back-scattered solar radiation from the earth-atmospheric system detected by meteorological satellites can be used to derive surface solar radiation, a number of satellite-based solar radiation models have been proposed to estimate the radiation. The existing models can be categorized as the statistical and physical models. The statistical models have an advantage of simplicity, but they usually lack generality. In contrast, physical models offer more generality, however, they are more complex and require more input data. As a compromise, in this work we proposed a semi-empirical model for estimating solar radiation from satellite data. The model expresses solar irradiance as a semi-empirical function of cloud index, aerosol optical depth, precipitable water, total column ozone and air mass. The cloud index data were derived from MTSAT-1R satellite, whereas the aerosol optical depth data were obtained from MODIS. The total column ozone data were derived from OMI/AURA satellite and the precipitable water data were obtained from NCEP/NCAR. A five year period (2006-2010) of these data and global solar irradiance measured at four sites in Thailand namely, Chiang Mai (18.78 N, 98.98 E), Nakhon Pathom (13.82 N, 100.04 E), Ubon Ratchathani (15.25 N, 104.87 E) and Songkhla (7.20 N, 100.60 E), were used to derive the empirical coefficients of the model. To evaluate its performance, the model was used to calculate solar radiation at other four sites in Thailand namely, Phisanulok (16.93 N, 100.24 E), Kanchanaburi (14.02 N, 99.54 E), Nongkhai (17.87 N, 102.72 E) and Surat Thani (9.13 N, 99.15 E) and the results were compared with solar radiation measured at these sites. It was found that the root mean square difference (RMSD) between measured and calculated values of hourly solar radiation is about 20%. The proposed model has the advantage in terms of the simplicity for applications with reasonable accuracy of the results.