

A solar radiation model with high spatial and temporal resolution from multi-sensor remote sensing data

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Abstract:

The accurate knowledge of solar radiation reaching the earth's surface is of great interest in meteorology, climate, and solar energy applications. The solar radiation data is also needed for land surface model development. As one of the most important atmospheric forcing data, the quality of solar radiation data greatly affects the ability of land surface models to simulate the surface energy balance. In this study, we have developed an solar radiation model to estimate long-term hourly global radiation with high temporal resolution of 1 hour and with a spatial resolution of 1km×1km under the all-sky conditions.

In the cloud-free atmosphere, the attenuation of solar irradiance due to scattering and absorption is calculated using the look-up table (LUT) based on the radiative transfer model 6SV (the Second Simulation of a Satellite Signal in the Solar Spectrum, Vector). In the clear-sky model, the aerosol optical depth, total precipitable water vapor and the surface albedo from the MODIS onboard the Terra and Aqua satellite, and the ozone data of TOMS were used in the LUT to simulate the surface direct radiation, diffuse radiation and global radiation at the horizontal surface for a great variety of realistic atmospheric and surface conditions. Then, the sinusoidal model is used to retrieve the diurnal variations of the clear-sky solar radiation with the instantaneous solar radiation estimate from the satellite.

In the cloudy day, the solar radiation is strongly affected by cloud cover. Attenuation due to clouds is taken into account by a cloud index derived from MTSAT-1R geostationary satellite. This process included three steps. The first step consists of a cloud detection procedure. The second determines the cloud index for each point on the satellite image. Then, the hourly cloudy index is used to correct the clear-sky solar radiation on the horizontal surface.

The effect of topography on the surface orientation was taken into account in the model. The spatial distributed model of the solar radiation using horizontal direct and diffuse radiation, and geographical parameters extracted from DEM (digital elevation model) was used to produce global solar irradiance over the mountainous areas in the Heihe River Basin.

The derived hourly global solar radiation with 1km resolution at the surface were evaluated against the pyranometer measurements from ground stations in Heihe River Basin

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