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Estimation of solar irradiance from satellite data and numerical weather predictions over Greece

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Cloudiness is the basic atmospheric parameter that influences the shortwave (SW) irradiance reaching the ground, due to its high temporal and spatial variability. Recently, the "Hellenic Network for Solar Energy" (HNSE) has been developed in Greece to support applications of solar energy with the combined use of ground based measurements, satellite images and theoretical calculations with radiative transfer and weather forecasting models. This study presents comparisons of total solar irradiance (TSI) measurements at the ground with estimates derived from the analysis of images recorded by the Meteosat Second Generation (MSG) satellite, cloud information from the Moderate Resolution Imaging Spectroradiometer (MODIS) and results from the Weather Research and Forecasting (WRF) model.

Taking advantage of the MSG spatial and temporal resolution (0.05°x0.05°, every 15 minutes), efforts have been made to estimate the global irradiance on the ground, based on cloud information from the satellite sensors and modeled irradiances under clear skies. The effect of clouds on solar radiation has been described by the cloud modification factor (CMF), defined as the ratio of the global irradiances under the presence of clouds and cloud free conditions respectively. The CMF is provided by the MSG signals at 0.6 and 12 μm when the sun and satellite azimuth and zenith angles, the ground reflectivity, altitude and aerosol optical depth are known. CMF data have been also calculated (at overpass times) by cloudiness information from the MODIS instrument, on board the Terra and Aqua satellites with 1°x1° spatial resolution. Solar irradiance calculations (LibRadtran package) have been multiplied with the CMF values for the estimation of TSI.

The prognostic meteorological model WRF has been incorporated in the system in order to facilitate forecasts of TSI received at the earth's surface under all weather conditions. The model provides hourly estimates of TSI for 3 days ahead covering the Greek territory in a grid of 10x10 km2.

Comparison of satellite and model derived estimation of TSI have been compared in different time scales with measurements at three locations in Greece (Athens, Thessaloniki and Patras) for a period of one year. The average agreement ranges between 5% and 10% for the three sites.