

MODIFICATION OF RADIATIVE TRANSFER MODEL FOR ESTIMATING
SOLAR IRRADIANCE OVER PENINSULAR MALAYSIA

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DEDICATION

To my beloved FAMILY

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ABSTRACT

The availability of atmospheric parameters is important in estimating solar irradiance using Radiative Transfer Model. Atmospheric data such as temperature, relative humidity, pressure and atmospheric trace constituent in the function of altitude are the basic requirement for estimating solar irradiance and it is very limited. Static atmospheric model such as Air Force Geophysics Laboratory Atmospheric Constituent Profiles does provide the required parameter however it is outdated and does not reflect the local atmospheric condition. A Local Static Atmospheric Model for Malaysia was built in this study to provide the needed atmospheric parameters. The model was built based on monthly data from Atmospheric InfraRed Sounder in a period of ten years at peninsular Malaysia and validated with local meteorological data. Along with the atmospheric model, simple model of the atmospheric radiative transfer of sunshine was rewritten in MATLAB environment with some minor modification that allows the local atmospheric model to be integrated into the radiative transfer model. The modified radiative transfer model takes five parameters for the calculation of the solar irradiance which are, date, time, longitude, latitude and altitude. It reduces the parameter needed by the conventional radiative transfer model such as the inputs of atmospheric parameter, pressure, zenith angle, path length, and earth-sun distance. The modified the radiative transfer model was design to include the local atmospheric model as the main atmospheric input which improve its accuracy and suitable to be used locally. The results of the study were compared with the solar flux data from Aerosol Robotic Network which return an overall correlation of 97% with 4.8% root mean square error for zenith angle below 60°.

ABSTRAK

Ketersediaan parameter-parameter atmosfera adalah penting bagi penganggaran sinaran suria dengan menggunakan model pemindahan sinaran. Maklumat atmosfera seperti suhu, kelembapan relatif, tekanan dan unsur surih atmosfera dalam fungsi ketinggian adalah keperluan asas bagi penganggaran sinaran suria dan ia adalah amat terhad. Model atmosfera statik seperti Profil Atmosfera Makmal Tentera Udara Geofizik ada menyediakan parameter-parameter yang diperlukan tetapi ia telah ketinggalan zaman dan tidak mencerminkan keadaan atmosfera tempatan. Model atmosfera statik tempatan untuk Malaysia dibina dalam kajian ini bagi menyediakan parameter-parameter atmosfera yang diperlukan untuk anggaran sinaran suria. Model ini dibina dengan menggunakan data bulanan daripada pengukuran inframerah atmosfera di Semenanjung Malaysia selama sepuluh tahun dan telah disahkan dengan data cuaca tempatan. Selain daripada model atmosfera, model mudah pemindahan atmosfera sinaran suria telah diprogramkan dalam persekitaran MATLAB dengan pengubahsuaian bagi membolehkan model atmosfera tempatan diintegrasikan dalam model pemindahan sinaran. Model pemindahan sinaran yang telah diubahsuai memerlukan lima parameter untuk membuat pengiraan sinaran suria iaitu tarikh, masa, longitud, latitud dan altitud. Ia mengurangkan parameter yang diperlukan oleh model pemindahan sinaran konvensional seperti parameter atmosfera, tekanan udara, sudut kemuncak matahari, jarak suria dalam atmosfera dan jarak bumi dengan matahari. Model pemindahan sinaran yang telah diubahsuai ini direka untuk menggunakan model atmosfera tempatan sebagai permasukan atmosfera utama yang meningkatkan ketepatan penganggaran dan sesuai digunakan untuk penganggaran tempatan. Keputusan kajian ini dibandingkan dengan data fluks suria daripada Rangkaian Robot Aerosol dengan korelasi sebanyak 97% dengan 4.8% punca min ralat kuasa dua bagi sudut kemuncak kurang daripada 60°.