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A hybrid numerical prediction scheme for solar radiation estimation in un-gauged catchments.

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The importance of solar radiation on earth's surface is depicted in its wide range of applications in the fields of meteorology, agricultural sciences, engineering, hydrology, crop water requirements, climatic changes and energy assessment. It is quite random in nature as it has to go through different processes of assimilation and dispersion while on its way to earth. Compared to other meteorological parameters, solar radiation is quite infrequently measured, for example, the worldwide ratio of stations collecting solar radiation to those collecting temperature is 1:500 (Badescu, 2008). Researchers, therefore, have to rely on indirect techniques of estimation that include nonlinear models, artificial intelligence (e.g. neural networks), remote sensing and numerical weather predictions (NWP).

This study proposes a hybrid numerical prediction scheme for solar radiation estimation in un-gauged catchments. It uses the PSU/NCAR's Mesoscale Modelling system (MM5) (Grell et al., 1995) to parameterise the cloud effect on extraterrestrial radiation by dividing the atmosphere into four layers of very high (6-12 km), high (3-6 km), medium (1.5-3) and low (0-1.5) altitudes from earth. It is believed that various cloud forms exist within each of these layers. An hourly time series of upper air pressure and relative humidity data sets corresponding to all of these layers is determined for the Brue catchment, southwest UK, using MM5. Cloud Index (CI) was then determined using (Yang and Koike, 2002):

$$c_i = \frac{1}{p_{bi} - p_{ti}} \int_{p_{ti}}^{p_{bi}} \max \left[0.0, \frac{(Rh - Rh_{cri})}{(1 - Rh_{cri})} \right] dp$$

where, p_{bi} and p_{ti} represent the air pressure at the top and bottom of each layer and Rh_{cri} is the critical value of relative humidity at which a certain cloud type is formed.

Output from a global clear sky solar radiation model (MRM v-5) (Kambezidis and Psiloglu, 2008) is used along with meteorological datasets of temperature and precipitation and astronomical information. The analysis is aided by the Gamma Test (GT). GT is a newly developed algorithm (Koncar, 1997; Agalbjorn, *et al.*1997) that helps in estimating the best mean squared error (MSE), for a given combination of inputs when modelling an unseen data. The study also explores the ability of GT to determine the optimum data length and optimum number of nearest neighbours for nonlinear modelling of global solar radiation in un-gauged catchments. Artificial neural networks (ANN) and Local linear regression based nonlinear models have been used to test the proposed methodology and the results have shown a high degree of correlation between the observed and estimated solar radiation data. It is believed that this study will initiate further exploration of GT for improving informed data and model selection.

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