ESTIMATION OF GLOBAL RADIATION USING MORTON'S METHOD

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Introduction

Solar radiation is the energy source for the physical and biological processes taking place at the earth's surface. It is less frequently measured than other meteorological parameters and numerous models have been proposed for its estimation(Kasten 1983,Kamel et. al., 1993,Thornton and Running 1999, Liu and Scott 2001) Solar radiation data is necessary in studies of evapotranspiration and photosynthesis. In the present paper solar radiation at the surface or global radiation at some stations in Paraiba state is evaluated using Morton's(1983) procedure. Crop growing periods in different parts of the state lie between the months of February and October (Karuna Kumar et. al., 1999).Hence the present investigation is confined to this nine month period at the selected stations.

Methodology

Mean monthly values of air temperature, vapour pressure and sunshine at five stations in the state are used in this study.
The extraterrestrial solar radiation (G_E) for each month of the year is computed using standard equations. The precipitable water vapour (W) in mm and the turbidity coefficient (J) are calculated as follows:

$$W = \frac{V_d}{0.49 + \frac{T}{129}} \quad (1)$$

$$J = \left(0.5 + 2.5\cos^2 z\right) e \exp\left(c_1 \left(\frac{p}{p_s} - 1 \right) \right) \quad (2)$$

$c_1 = 21 - T$ and $0 \le c_1 \le 5$

Where p is the station pressure ,ps is 1013 mb, Vd is the vapour pressure in mb , T is the air temperature in ºC and z is the average solar zenith distance.
The transmittancy of clear skies to direct solar radiation (τ) is

$$\tau = \exp[-0.089(p/(p_s \cos z))^{0.75} - 0.083(J/\cos z)^{0.9} - 0.029(w/\cos z)^{0.6}] \quad (3)$$

The part of τ that is the result of absorption τ_a is given by

$$\tau_a = \exp[-0.0415(J/\cos z)^{0.9} - 0.0029^{0.5} (w/\cos z)^{0.3}] \quad (4)$$

$$\tau_a \bar{e} \exp[-0.0415(J/\cos z)^{0.9} - 0.029 (w/\cos z)^{0.6}]$$

The clear sky global radiation (G_0) is obtained from the expression

$$G_0 = G_E \tau \left[1 + \left(1 - \frac{\tau}{\tau_a} \right) \left(1 + \alpha_0 \tau \right) \right] \quad (5)$$

Where α_0 , the clear sky albedo is derived from a procedure suggested by Morton (1983).
The global radiation is finally computed from the equation

$$G = SG_0 + (0.08 + 0.30S)(1 - S)G_E \quad (6)$$

Where S is the sunshine ratio.

Results

Measured and estimated values of global radiation at five stations in Paraiba state are presented in Table 1. For the nine month period the mean difference between the measured and estimated values ranged between 2% at São Goncalo to 5.5% at Campina Grande. At Patos, Monteiro and Areia the differences are 2.9%,4.3% and 4.9% respectively. Based on data for all the stations the mean percentage error in the estimation of global radiation is 3.9%.The closest agreement between measured and estimated values is noticed in April when the mean difference is less than 1.5%.

Equation 6 is a modified version of Rietweld's (1978) expression for the transmissivity of cloudy skies and is based on data from Yugoslavia, Sweden Portugal and Holland. If radiation data for a large number of stations in NE Brazil is available it might be possible to adjust this equation to climatic conditions of this region.

Conclusions

Mean monthly values of global radiation at five stations in Paraiba are evaluated using air temperature, vapour pressure and sunshine data and the results are compared with measured global radiation. The mean difference between the estimated and the measured value is less than 4%.

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Table 1 Observed and estimated values of global radiation (cal. cm^{-2}. day^{-1}) at five stations in Paraíba State.

Month	S. Gonçalo		Patos		Monteiro		Areia		C. Grande	
	Obs.	Est.	Obs.	Est.	Obs.	Est.	Obs.	Est.	Obs.	Est.
Feb	507	530	513	529	482	536	459	480	457	493
Mar	528	503	525	538	489	515	463	460	457	460
Apr	486	471	482	491	459	455	441	437	409	412
May	460	452	433	430	400	389	360	380	358	346
Jun	420	425	394	401	371	362	347	294	322	290
Jul	443	439	402	399	376	358	342	305	329	292
Aug	528	518	491	508	476	482	420	412	395	402
Sep	565	567	533	560	506	517	449	454	434	456
Oct	599	604	561	603	541	590	498	517	477	522