ESTIMATION OF GLOBAL RADIATION AT SOME STATIONS IN NE BRAZIL

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ABSTRACT - Mean monthly values of global radiation at 16 stations in NE Brazil are evaluated using temperature vapor pressure and sunshine data and the results are compared with measured global radiation values.

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 many models have been suggested for its estimation (Iqbal, 1983) \In this paper mean monthly values of global radiation for 16 stations in northeast Brazil are evaluated using Morton's (1983) procedure and the results are compared with measured values.

MATERIAL AND METHODS

Mean monthly values of air temperature, vapour pressure and sunshine for the months of February to October at 16 stations in NE Brazil 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:

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

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

$c_1 = 21 - T$ 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

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

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

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 AND DISCUSSION

Measured and estimated values of global radiation at the selected stations during the period February-October are presented in Table 1. For the nine month period the mean difference between the measured and estimated values ranges between 1.9% at São Gonçalo to 5.8% at Caravelas. Based on data from all the stations the mean percentage error in the estimation of global radiation is 4.3%. For the month of June the error is rather small being less than 3.5% at twelve out of sixteen stations.

Eq. 6 is a modified version of Rietveld's (1978) expression and is based on data for stations in Yugoslavia, Sweden, Portugal and Holand. If global radiation and sunshine data for several years is available for many stations in NE Brazil it might be possible to adjust this equation to climatic conditions of the region.

Climatological data for different locations in NE Brazil is used in this study. The difference between the measured and estimated values of global radiation is quite small and the model can therefore be of much use for the estimation of global radiation at stations where only temperature vapour pressure and sunshine data are available.

REFERENCES

Iqbal, M. 1983. an introduction to solar radiation. Toronto. Academic Press. 390 p.

Kamel,M.A Shalaby,S.A,and Mostafa .S.S. 1993 Solar radiation over Egypt: Comparison of predicted and measured meteorological data. Sol. Energy. 50: 463-467

Liu,D.L., Scott.B.J., 2001. Estimation of solar radiation in Australia from rainfall and temperature observations. Agric. For. Meteorol.106: 41-59

Morton,F.I. 1983 Operational estimates of areal evapotranspiration and their significance to the science and practice of hydrology. J. Hydrology, 66: 1-76

Thornton, P.E., Running,S.W., 1999 An improved algorithm for estimating incident daily solar radiation from measurements of temperature , humidity and precipitation .Agric. For. Meteorol. 93: 211-228.

Rietveld, R. M. 1978. A new method for estimating the regression coefficients in the formula relating solar radiation to sunshine. Agric. Meteorology, 19: 243-252.

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Table 1: Measured (M) and calculated (C) values of global radiation (cal. cm^{-2}. day^{-1}).

Station	M/C	Feb.	Mar.	Apr.	May	Jun.	Jun.	Jul.	Aug.	Sep.	Oct.
Cruzeta	M	506	494	473	435	406	406	403	493	532	541
	C	515	478	431	419	393	393	388	484	548	587
Floriano	M	393	433	419	416	433	433	446	502	522	490
	C	405	405	419	436	447	447	476	544	563	528
Irece	M	533	516	459	390	386	386	411	471	505	497
	C	553	519	453	386	378	378	411	484	524	536
Quixeramobim	M	444	444	419	396	380	380	398	462	494	499
	C	480	439	406	398	386	386	420	497	550	557
Recife	M	512	481	421	379	345	345	348	441	489	530
	C	524	463	404	355	312	312	304	406	469	532
Sobral	M	445	424	422	406	406	406	425	487	523	520
	C	435	384	365	394	395	395	425	501	542	548
Barbalha	M	440	440	432	408	399	399	412	497	512	513
	C	461	435	419	414	400	400	416	504	548	544
Barreiras	M	487	468	461	410	416	416	433	485	496	455
	C	472	464	440	424	424	424	447	513	509	452
B.J. de Lapa	M	489	492	448	398	400	400	405	460	480	462
	C	537	503	448	412	391	391	420	482	515	494
Cabrobo	M	491	492	451	388	363	363	367	473	505	548
	C	534	482	432	357	340	340	353	462	519	588
Caravelas	M	562	497	407	349	312	312	332	398	392	397
	C	577	472	384	322	283	283	289	366	390	401
Crateús	M	432	441	433	411	396	396	423	479	510	502
	C	438	405	395	399	404	404	437	515	544	557
São Gonçalo	M	507	528	486	460	420	420	443	528	565	599
	C	530	503	471	452	425	425	439	518	567	604
Patos	M	513	525	482	433	394	394	402	491	533	561
	C	529	538	491	430	401	401	399	508	560	603
Monteiro	M	482	489	459	400	371	371	376	476	506	541
	C	536	515	455	389	362	362	358	482	517	590
Campina Grande	M	457	457	409	358	322	322	329	395	434	477
	C	493	460	412	346	290	290	292	402	456	522