Journal of Agrometeorology5 (1) : 97-101 (June 2003)

Forecasting grass minimum temperature for Coimbatore

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ABSTRACT

A regression model using dry bulb temperature (DBT) and dew point temperature (DPT) recorded both at 14.22 hrs was developed to predict the next day grass minimum temperature (GMT) of coimbatore. By using the model, GMT was predicted for all months and there was no significant difference between observed and predicted values as indicated by Chi-square test and the model was found valid.

Key words : Grass minimum temperature, Frost, Regression model, Validation.

Study of temperature is of prime interest to Agro-meteorologists as it influences crop production in many ways. There are two type of frost, one is radiational frost, it occurs due to excessive radiational cooling of the ground surface on clear and fairly calm nights and dry weather, second is advection frost i.e., by wind circulations bringing in air from cold regions. Ventskevich (1961) listed critical temperatures for different crops for frost damage in various phenological stages. Growe (1971) stated that occurrence of temperature inversions at night must have a marked effect upon the incidence of 'ground frost'. The importance of grass minimum temperature (GMT) measurements for agricultural purposes had previously emphasized by Geiger (1945), Baier and Edey (1970), Birch and Treidl (1973). GMT is read directly from grass minimum thermometer or terrestrial radiation thermometer. In the absence of this thermometer equations (Bootsma, 1976) are used to predict GMT. Saturation vapor pressure (SVP) was used to estimate the GMT for Coimbatore, India (Balasubramanian *et al*, 1997). Smith (1973) developed an equation to forecast GMT for Christchurch, New Zealand using dry bulb and dew point temperatures.

Here, an attempt was made to predict the GMT for Coimbatore by using dry bulb and dew point temperature of previous day evening.

MATERIALS AND METHODS

Daily data of dry bulb, dew point and grass minimum temperatures for the years 1997,1998 and 1999 were collected from Agrometeorological observatory records of Tamil Nadu Agricultural University, Coimbatore. In order to extend the range of analysis, five sets (I toV) were prepared viz., for individual years (1997, 1998, 1999), average of three and total (1095 daily

Table 1 : Correlation between grass minimum and dry bulb and dew point temperatures.

Year	Sample size	Set	Dry bulb	Dew point
1997	365	I	0.1777**	0.6016**
1998	365	II	0.2429**	0.5634**
1999	365	III	-0.007	0.6944**
3 year Average	365	IV	0.2483**	0.7098**
Total	1095	V	0.1434**	0.6145**

** Significant at P = 0.01

readings for these years). Correlation and regression between daily GMT (recorded at sunrise) and previous day dry bulb and dew point temperatures (recorded at 14.22 hrs) were worked out using Microsoft Excel package.

RESULTS AND DISCUSSION

Daily GMT was significantly correlated with previous day DBT and DPT in all the cases except for those of DBT during 1999 (Table 1). The correlation coefficient (r) between GMT and dry bulb temperature varied from -0.007 for 1999 and 0.2483 for 3 years average. The corresponding coefficients (r) for the dew point temperature were between 0.5634 for 1998 and 0.7098 for 3 years average.

Regression model

The following regression models are developed using the best correlated variables for 3 years average data set

$$GMT = 9.0637 + 0.5281\ DBT \quad (R^2 = 0.43)$$

$$GMT = -7.4686 + 0.4295\ DBT + 0.693DPT \quad (R^2 = 0.45)$$

GMT = Grass minimum temperature forecasted, DBT = Dry bulb temperature (°C) & DPT = Dew point temperature (°C) at 14.22 hrs IST

By using above regression models the GMT was predicted and compared with observed values (Table 2). The Chi-square (x^2) values are presented in Table 3.

In order to compare the models for different months, the actual GMT for the dates 1 to 5 in each month starting from September 1999 to August, 2000 were used and compared with predicted values. The different between observed and predicted values of model 1 ranges - 5.8 to 4.2 and it was - 5.7 to 4.8 for model 2 (Table 2). The calculated Chi-square (χ^2) values for model 1 varied from 0.187 to 3.017 and for model 2, it was 0.267 to 2.932 (Table 3). These are smaller than the table Chi-square (χ^2) value of 9.438 (P = 0.05 at n-1 df). The test established the validity of models. However, inclusion of DBT (model 2) did not improve the prediction values over model 1.

The model 1 with DPT alone can be used to predict the GMT of any particular

Table 2 : Actual and predicted GMT with DPT (model 1) and DBT + DPT (model 2) for different months

Month & date		Observed	Predicted			
		(°C)	Model 1	Difference	Model 2	Difference
Sep' 1999	1	19.0	18.8	0.2	19.4	-0.4
	2	18.5	18.0	0.5	18.2	0.3
	3	21.2	17.0	4.2	16.8	4.4
	4	20.5	17.4	3.1	17.4	3.1
	5	21.0	18.5	2.5	17.5	3.5
Oct' 1999	1	20.5	20.0	0.5	20.3	0.2
	2	20.0	20.2	0.2	20.2	0.2
	3	20.5	19.8	0.7	18.8	1.7
	4	19.0	20.5	-1.5	17.8	1.2
	5	20.0	21.1	-1.1	20.7	-0.7
Nov'1999	1	18.0	19.0	-1.0	18.8	-0.8
	2	18.5	20.7	-2.2	20.9	-2.4
	3	18.0	20.1	-2.1	19.1	-1.1
	4	19.0	20.0	-1.0	19.9	-0.9
	5	18.5	20.8	-2.3	17.8	0.7
Dec'1999	1	20.5	17.7	2.8	15.7	4.8
	2	21.0	19.6	1.4	18.4	2.6
	3	20.0	19.4	0.6	17.7	2.3
	4	18.0	19.0	-1.0	17.1	0.9
	5	16.5	19.4	-2.9	18.0	-1.5
Jan'2000	1	15.5	16.9	-1.4	14.8	0.7
	2	16.5	17.2	-0.7	15.0	1.5
	3	15.0	17.8	-2.8	15.7	-0.7
	4	16.0	18.6	-2.6	16.5	-0.5
	5	15.0	18.4	-3.4	16.5	-0.5
Feb 2000	1	15.0	14.9	0.1	13.3	1.7
	2	13.5	14.3	-0.8	12.2	1.3
	3	14.0	18.8	-4.8	18.2	-4.2
	4	14.5	20.3	-5.8	20.2	-5.7
	5	18.0	19.5	-1.5	17.7	0.3
Mar'2000	1	16.5	15.7	0.8	13.8	2.7
	2	14.0	13.4	0.6	11.5	2.5
	3	12.5	14.1	-1.6	13.1	-0.6
	4	14.0	15.1	-1.1	14.9	-0.9

Table 2 continue

	5	13.5	12.1	1.4	11.0	2.5
Apr'2000	1	19.0	21.7	-2.7	24.4	-5.4
	2	20.0	20.2	-0.2	21.0	-1.0
	3	19.5	19.3	0.2	20.2	-0.7
	4	19.0	20.8	-1.8	22.7	-3.7
	5	19.5	18.6	0.9	19.7	-0.2
May'2000	1	20.5	20.4	0.1	22.9	-2.4
	2	21.5	20.6	0.9	23.0	-1.5
	3	20.0	19.9	0.1	21.9	-1.9
	4	21.0	19.4	1.6	21.3	-0.3
	5	21.5	20.2	1.3	21.2	0.3
June 2000	1	18.5	18.6	-0.1	16.2	2.3
	2	20.0	18.4	1.6	17.9	2.1
	3	19.0	18.5	0.5	17.4	1.6
	4	20.0	19.1	0.9	20.0	0.0
	5	20.0	18.4	2.6	17.6	3.4
July2000	1	18.5	18.6	-0.1	16.2	2.3
	2	20.0	18.4	1.6	17.9	2.1
	3	19.0	18.5	0.5	17.4	1.6
	4	20.0	19.1	0.9	20.0	0.0
	5	20.0	19.3	0.7	18.4	1.6
Aug 2000	1	21.0	19.7	1.3	20.9	0.1
	2	19.5	20.0	0.5	20.9	0.1
	3	22.0	19.8	2.2	20.6	1.4
	4	20.0	20.7	-0.7	21.3	-1.3
	5	21.8	21.7	0.1	22.3	-0.5

day and also to calculate the GMT in the absence of grass minimum thermometer at Coimbatore. Bootsma (1976) stated that it is not always possible to extrapolate the regression model to predict GMT for other location as GMT markedly changes with respect to topography, soil and surface characteristics. It could be seen from Table 2 that on a very few occasions, predicted values deviated by 3 to 5° C or more from those observed. These need further examination with respect to synoptic weather conditions which is not attempted here.

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Table 3 : Chi-square ($\chi 2$) values for models with DPT (model 1) and DBT + DPT (model 2) in different months

Month	Model 1	Model 2
1999		
September	1.094	2.393
October	0.207	0.267
November	0.820	0.445
December	1.072	2.298
2000		
January	1.600	0.337
February	3.017	2.932
March	0.485	1.710
April	0.545	1.862
May	0.271	0.522
June	0.752	1.683
July	0.187	0.870
August	0.358	0.272

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