



Reweigh Temperature as Estimator for Evaluation and Prediction

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Authors' contributions

This work was carried out in collaboration between both authors. Authors MKA and DP the authors managed the literature search writing of the final manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

This study aimed to develop estimator for evaluation of reweigh temperature for prediction research extent. Research conducted in Jabalpur district of Madhya Pradesh, India, which comes under the humid subtropical climate region. Temperature recorded at one hour, two hour or three hour either side of maximum temperature may be averaged to get a plateaued value for that much time period. Hourly data on temperature recorded at Weather Underground site are regrouped into different temperature forms namely average of maximum and minimum temperature (T_{av}), weighted temperature (T_{wt}), maximum temperature (T_{max}), Temperature plateaued one hour, two hour and three hour either side of maximum temperature (T_{p_2} , T_{p_4} and T_{p_6} respectively). These temperature forms are plotted for all twelve months. Integration of T_{av} and T_{max} was done for estimation of weighted temperature. Values of coefficient of determination raised from fitting of linear regression between each of temperature form; T_{max} , T_{av} , T_{wt} , T_{p_2} , T_{p_4} and T_{p_6} with actual pan evaporation. Data set comprises of daily records separately for all twelve months. Daily records are also regrouped into four more categories i.e. for whole year (365 days), hot months (April-May), cold months

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(December- January) and wet months (July-August). Though the r-squared values are found very low and explains that temperature alone cannot be taken as predictor of evaporation, which is a well comparative fact, but the purpose of presenting these values here to show the comparative effect of different temperature forms on evaporation. In hot months, the T_{wt} with r-squared values of 0.49 seems to be more correlated than other temperature forms. But, in cold months T_{max} , T_{p_2} , T_{p_4} and T_{p_6} have more influence on evaporation than the T_{av} or T_{wt} . The research outcome of the present study will be helpful to estimation of reweigh temperature rather average of maximum and minimum temperature for use in prediction research work.

Keywords: Estimator; evaporation; reweigh temperature.

1. INTRODUCTION

Temperature has been used to estimate evaporation and evapotranspiration etc. for understanding hydrologic behavior of an area. Mostly, maximum temperature, minimum temperature or average temperature are the basis for many estimates. A particular temperature form is generally used for whole year irrespective of the season, for these estimates.

With the advent of temperature data logger and its deployment in many recording stations, it is now possible to have temperature records for any specified discrete time interval and it make possible to have weighted temperature rather average of maximum and minimum temperature for use in prediction research.

2. MATERIALS AND METHODS

The temperature peaked in a day for instance and considering this maximum value may not represent the actual warmth correctly, therefore, a plateaued value of temperature in hotter hours of the day with acceptable percentage difference with peaked temperature shall be a better choice. Temperature recorded at one hour, two hour or three hour either side of maximum temperature may be averaged to get a plateaued value for that much time period. In real sense, this is the warmth which affects the amount of water losses the most. As temperature increases the rate of evaporation also increases due to increasing kinetic energy of the surface molecules which leads them to free and became vapour.

An attempt has been made in present paper to develop understanding to reweigh temperature as an estimator. Data set comprises of daily records separately for all twelve months. Daily records are also regrouped into four more categories i.e. for whole year (365 days), hot months (April-May), cold months (December-January) and wet months (July-August). Hourly

data on temperature recorded at Weather Underground site are regrouped into different temperature forms namely average of maximum and minimum temperature (T_{av}), weighted temperature (T_{wt}), maximum temperature (T_{max}), Temperature plateaued one hour, two hour and three hour either side of maximum temperature (T_{p_2} , T_{p_4} and T_{p_6} respectively). These temperature forms are plotted for all twelve months and are presented in Fig. 1 and Fig. 2. In cold months i.e. December and January the T_{wt} is always found significantly lower than T_{av} (Table 1), whereas in hotter months like April and May both T_{wt} and T_{av} are apparently braided together.

In Fig. 1 and Fig. 2 the T_{wt} values are found mostly below the T_{av} values but it is found significantly lower in cold months (Table1). The difference between maximum temperature values with plateaued T_{p_2} , T_{p_4} and T_{p_6} temperature is not significantly different in cold months. While in hotter months i.e., in April and May, the T_{wt} somewhat clubbed with T_{av} and difference between the T_{max} and plateaued T_{p_2} , T_{p_4} and T_{p_6} are found significantly different.

To see its influence, the evaporation data are correlated with each of temperature form linearly only as Baier and Robertson [1] in their evaluation of meteorological factors influencing evaporation found that the use of complex logarithmic, quadratic and cubic regression models does not significantly improve the estimation of evaporation as calculated from a linear regression.

The higher the temperature of the substance the greater the KE of the molecules at its surface and therefore the faster the rate of their evaporation. Evaporation rate from the water surface is a function of meteorological conditions of the overlying air, the energy state of the air-water interfacial zone and amount of energy stored in the water body. Evaporation is a joint

influence of several meteorological parameter in which temperature is supposed to be most influential. A large number of model have been proposed for estimating evaporation from water surface using climatic data [2]. Temperature based methods such as Blaney-criddle, Hargreves, Thornthwaite, Linacre, Kharrula and Hamon when tested by Xu and Singh [3] recalibrated constant values of temperature for local condition. Lesser biases existed in most of above equation. This promote use of near factual values of temperature. Mostly evaporation estimation methods either use value of maximum/minimum or average temperature values. In Liu [6] if weighted temperature is used it may give different biases, because capricious temperature with respect to time is itself a resultant of influential parameter these affects evaporation process.

3. RESULTS AND DISCUSSION

Values of coefficient of determination arised from fitting of linear regression between each of temperature form; T_{max} , T_{av} , T_{wt} , Tp_2 , Tp_4 and Tp_6 with actual pan evaporation data are presented in Table 2. Data set comprises of daily records separately for all twelve months.

The r-squared values are found very low and explains that temperature alone cannot be taken as predictor of evaporation, which is a well comparative fact, but the purpose of presenting these values here to show the comparative effect of different temperature forms on evaporation.

A squint look through Table-2 reveals following facts.

1. In hot months, the T_{wt} with r-squared values of 0.49 seems to be more correlated than other temperature forms.
2. In cold months T_{max} , Tp_2 , Tp_4 and Tp_6 have more influence on evaporation than the T_{av} or T_{wt} .
3. In extreme temperature months, whether the hottest-May or the coldest-January, the temperature affects the least on evaporation as seen through lesser value of r square.
4. In season transition months like February and October, the temperature in any form affect the evaporation the most as depicted through higher r square values.
5. In wet months it seems that temperature and evaporation are the least correlated.

Table 1. Difference significance among different temperature forms

Months	B/w T_{av} & T_{wt}		B/w T_{max} & Tp_2		B/w T_{max} & Tp_4		B/w T_{max} & Tp_6	
	$F_{critical}$	F_{cal}	$F_{critical}$	F_{cal}	$F_{critical}$	F_{cal}	$F_{critical}$	F_{cal}
Hot	1.53	1.08	0.65	0.93	0.65	0.93	0.65	0.91
Cold	0.65	0.92	1.52	1.00	1.52	1.00	1.52	1.00
Wet	1.53	1.45	1.52	1.07	1.52	1.22	1.52	1.37

Table 2. Coefficients of determination - Evaporation V_s Temperature forms $^{\circ}C$

Month	Temperature form, $^{\circ}C$					
	T_{av}	T_{wt}	T_{max}	Tp_2	Tp_4	Tp_6
January	0.0647	0.0894	0.1035	0.1062	0.1117	0.1142
February	0.2759	0.2796	0.2227	0.2424	0.2437	0.2539
March	0.1082	0.1381	0.1235	0.0927	0.1102	0.1249
April	0.1817	0.2418	0.1615	0.1591	0.1701	0.1761
May	0.0037	0.0213	0.0280	0.0166	0.0117	0.0062
June	0.2947	0.2675	0.2879	0.2143	0.2243	0.2275
July	0.0667	0.0579	0.0631	0.0417	0.0448	0.0437
August	0.0004	0.0007	0.0060	0.0102	0.0058	0.0020
September	0.1539	0.1760	0.2361	0.1238	0.0847	0.1562
October	0.3941	0.3387	0.3027	0.3147	0.3127	0.3071
November	0.0508	0.0427	0.0250	0.0290	0.0293	0.0295
December	0.0352	0.0330	0.0112	0.0128	0.0156	0.0159
Year 2018	0.5654	0.5599	0.6217	0.5977	0.6060	0.6112
Hot	0.4729	0.4939	0.3762	0.3304	0.3441	0.3500
Cold	0.0208	0.0235	0.0590	0.0633	0.0648	0.0680
Wet	0.0359	0.0255	0.0280	0.0149	0.0177	0.0200

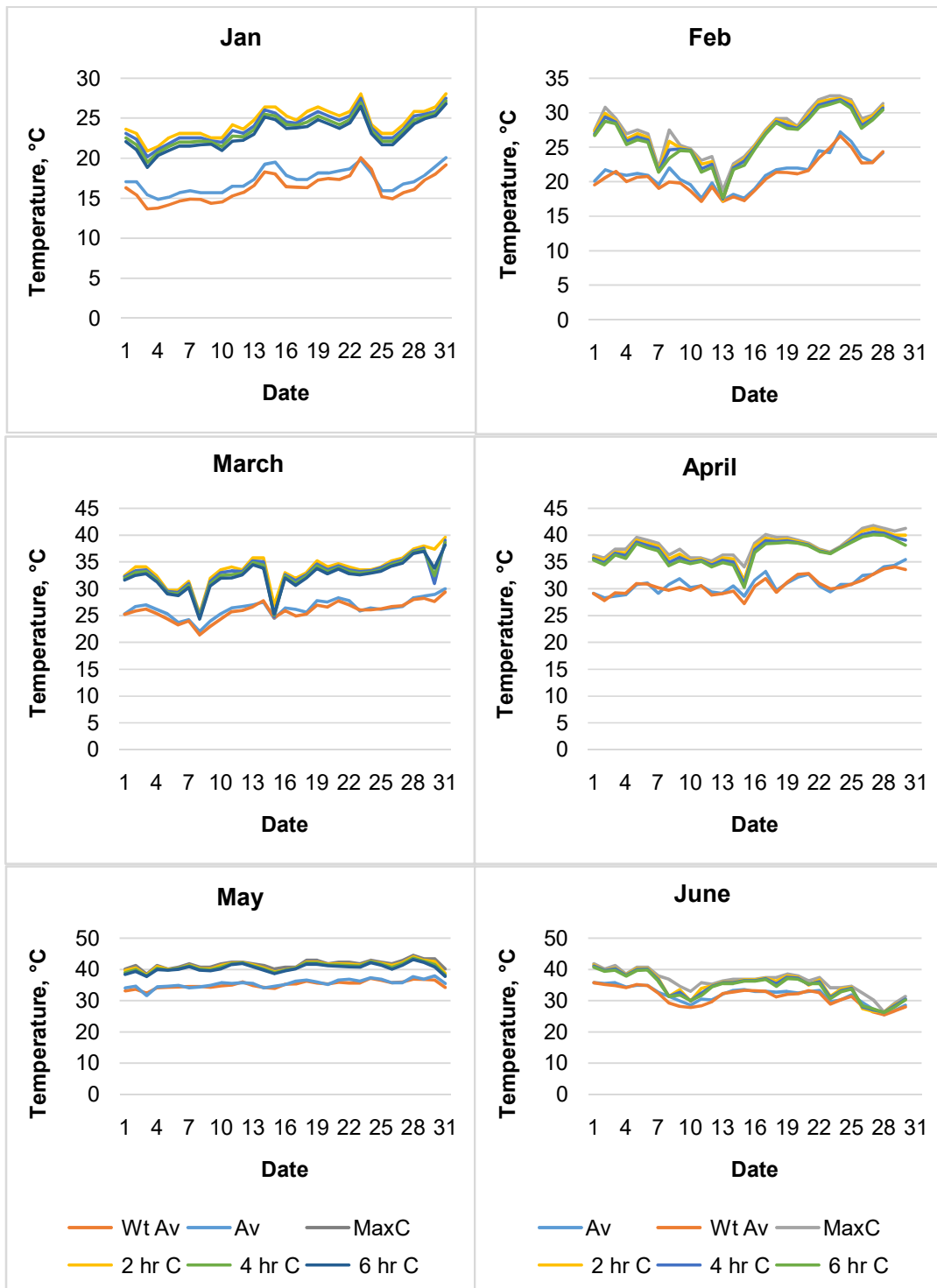


Fig. 1. Variation of temperature form-January to June

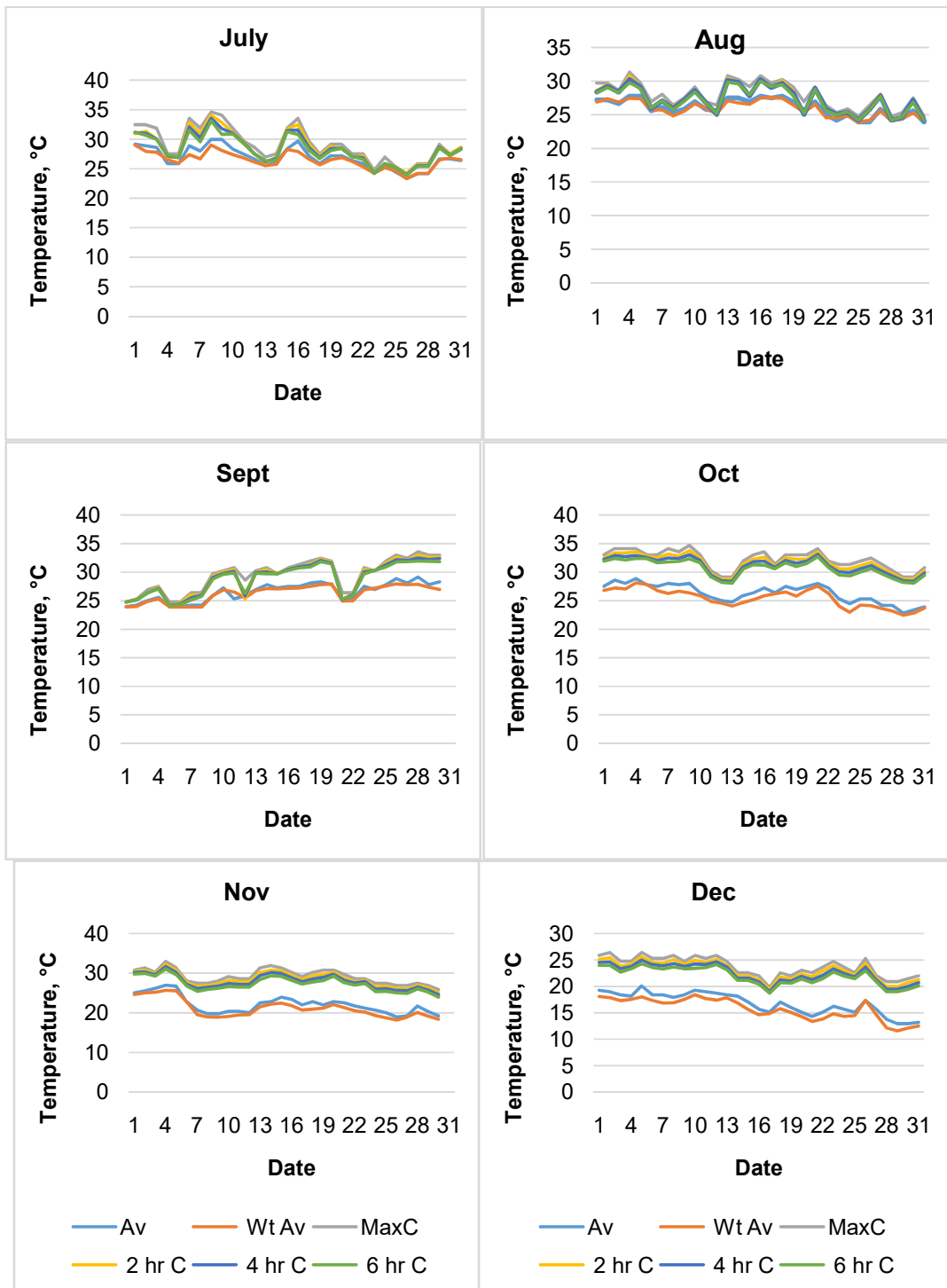


Fig. 2. Variation of temperature form-July to December

4. CONCLUSION

T_{wt} seems to be better predictor of evaporation in hot months like April and June while plateaued

temperature T_{p_2} , T_{p_4} and T_{p_6} which have within 10% variation with T_{max} may be taken as evaporation estimator in cold months. This should be taken in the light of finding of fact that

decrease in pan evaporation have been reported around the world despite increasing air temperature. This was attributed to reduction in wind speed and solar radiation [4-10].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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