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Comparison of Measured and Calculated Evapotranspiration Over Maize in Kirklareli

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Abstract

Determination of evapotranspiration is an important issue particularly for water management considering its role as part of the hydrological cycle associated with the losses. Especially in the countries like Turkey, where the economy is majorly based on agriculture, water management is a crucial application. For an accurate water management, possible losses should be determined. For this aim, evapotranspiration data was collected by micrometeorological methods from an agricultural system over maize crop surface for 2010-2011 growing seasons in Thrace Region which is located in the northwestern part of Turkey, Kırklareli. Further, obtained values were compared to the calculated values by the equations which take part in literature. For the study area, reference evapotranspiration over maize and potential evapotranspiration values were calculated to use in water budget calculations.

Keywords: Evapotranspiration, Kırklareli, Maize

INTRODUCTION

Determination of evapotranspiration (ET) is an important issue particularly for water management considering its role as part of the hydrological cycle associated with the losses. Especially in the countries like Turkey, where the economy is majorly based on agriculture, water management is a crucial application. For an accurate water management, possible losses should be determined.

ET is not always measured in meteorological stations, usually calculated by the equations which take part in literature. In this study different approaches used to calculate ET were compared to the measured data which was collected by a micrometeorological method (Bowen Ratio Energy Balance) over maize crop surface for 2010-2011 growing seasons in Thrace Region which is located in the northwestern part of Turkey, Kırklareli.

STUDY AREA

Experiment field covers 3.1 ha and is located in the research area of Atatürk Soil Water and Agricultural Meteorology Research Institute Directorate (ARID) (41°41'53'' N, 27°12'37'' E, 170 asl), in the Kırklareli City (Figure 1).

DATA and METHOD

In this study measured ET values were obtain by Bowen Ratio Energy Balance (BREB) method. Bowen Ratio Energy Balance (BREB) is a micrometeorological method is used to determine ET in this study. Latent heat flux is computed from surface energy budget components and Bowen Ratio (ratio of sensible to latent heat fluxes) in this method [1].

The BREB is expressed in the form by approximating the fluxes by the temperature and humidity gradient. Temperature gradient (ΔT) and specific humidity (Δq) is the differences between different levels of air temperature and humidity measurements.

In our study, measurements are at 2 m and 3 m level over surface area. Daily averaged data of temperature and humidity profile in the surface boundary layer for estimating surface energy fluxes and ET. BREB system used in this study is shown in Figure 2.

BREB is used to determine Kc, in water use studies [2], and plan-water relation studies [3] with continuous and high temporal scale (less than 1 h) data. In addition, this method does not require surface aerodynamic resistance information to estimate actual ET and apply different surface area [4].

The ET measurements were taken over maize crop for 2010 and 2011 growing seasons. 2010 season from planting to harvesting covers the period between 27.04.2010-24.09.2010 while 2011 growing season is between 26.04.2011-23.09.2011 (totally 151 days for both two seasons). Phenological stages of maize during growing seasons can be seen in Figure 3.

RESULTS

For the comparisons, 18 different equations were used to calculate potential or reference ET. These equations are temperature-based Schendel [5]; radiation-based Makkink [6], Turc [7], Jensen-Haise [8], McGuinness and Bordne [9], Priestley Taylor [10], Jones Ritchie [11], Hargreaves [12], Hargreaves and Samani [13], Irmak [14]; mass transfer-based Dalton [15], Trabert [16], Meyer [17], Albrecht [18], Brockamp and Wenner [19], WMO [20], Mahringer [21]; and combined FAO56 Penman Monteith [22] equations. These equations are mainly based on meteorological variables like global solar radiation, maximum, minimum and mean air temperature, relative humidity, air pressure, vapor pressure, wind speed etc.

Table 1 shows total calculated potential and reference ET values by 18 different equations and measured (ETactual) during 2010 and 2011 growing seasons. Figure 4 also shows to compare the results of ET for both growing seasons.

Comparisons between actual and calculated values are given with the scatter plots individually in Figure 5.

CONCLUSIONS

The highest relations were detected when actual values are compared to the calculated values by Irmak, Jensen-Heise and Priestley Taylor equations. These are followed by Makkink and Penman-Monteith equations. The least relations were observed in the comparisons with ALBRECT, TURC and WMO equations.

It can be concluded that radiation-based methods are better to estimate ET, because equations with high correlation (Irmak, Jensen-Heise and Priestley Taylor) are radiation-based. Despite that, ALBRECT and WMO equations are based on mass transfer method and they failed to estimate real ET values. In addition, other mass transfer based equations as Trabert and Mahringer give the worst results.

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Table 1. Total ET Values during growing seasons.

	2010 TOTAL ET (mm)	2011 TOTAL ET (mm)
ETp (Albrect)	96	605
ETp (Brockamp&Wenner)	107	859
ETp (Dalton)	77	837
ETp (FAO Penman Monteith)	569	569
ETp (Hargreaves)	355	369
ETo (Hargreaves and Samani)	784	784
ETo (Irmak)	407	411
ETo (Jensen Haise)	425	425
ETo (Jones and Ritchie)	363	377
ETp (Mahringer)	136	499
ETo (Makkink)	285	296
ETp (McGuinness&Bordne)	259	268
ETp (Meyer)	73	828
ETp (Priestley Taylor)	592	616
ETo (Schendel)	741	835
ETp (Trabert)	62	477
ETp (Turc)	77	85
ETp (WMO)	109	430
ETactual	808	755

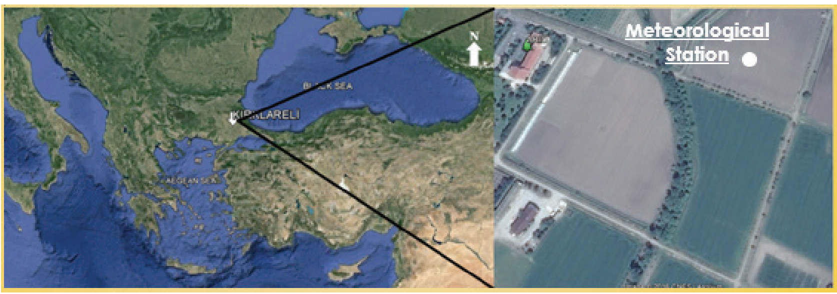

Figure 1. Experiment field in Kırklareli, Turkey.

Figure 2. BREB measurement system.

Figure 3. Phenological stages of maize.

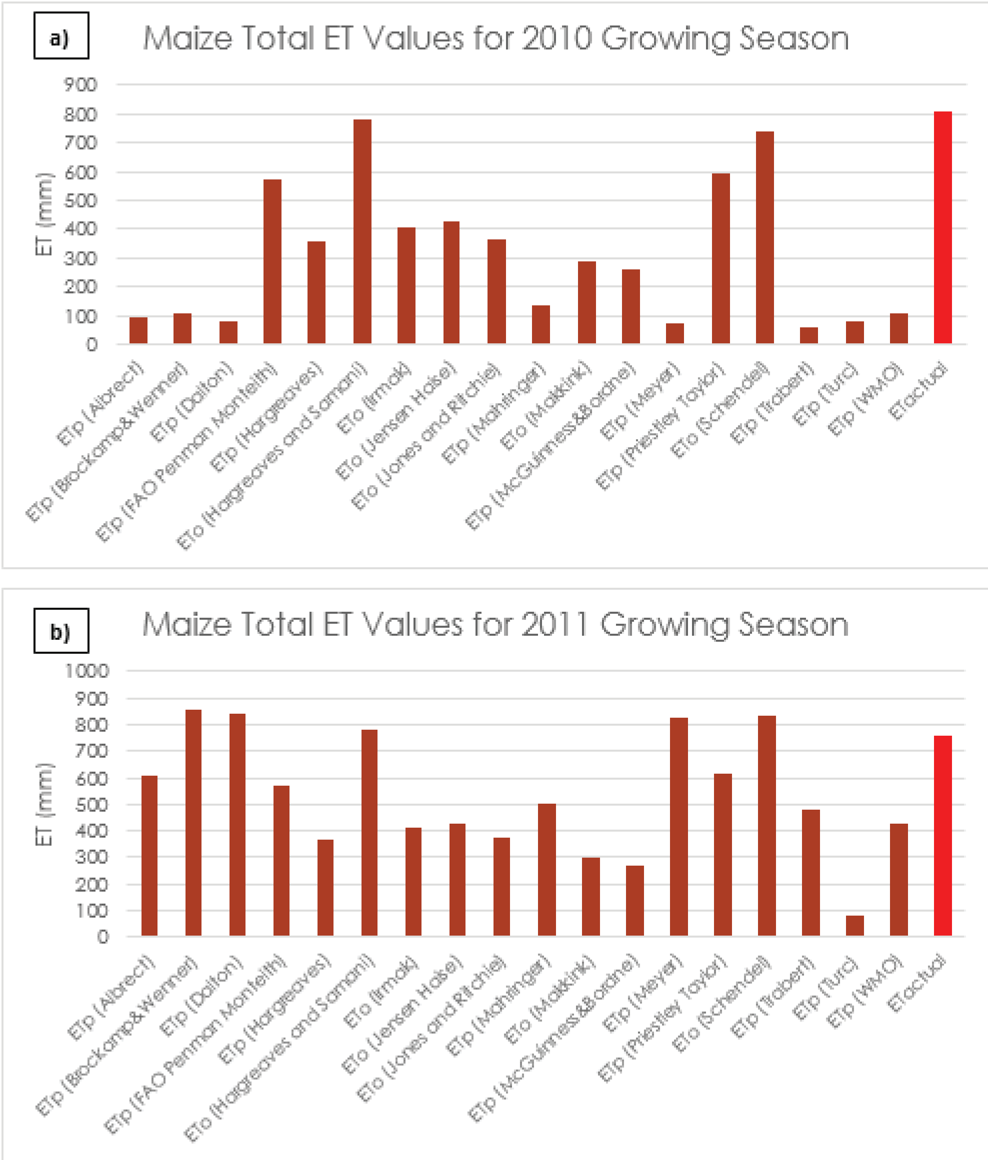

Figure 4. Maize total ET values for a)2010 growing season b) 2011 growing season.

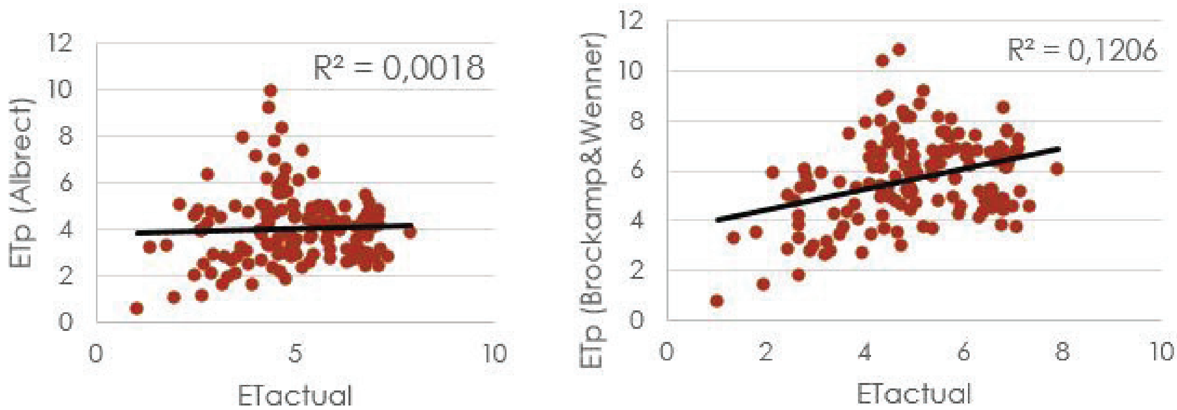

Figure 5. Scatter plots of calculated and measured ET

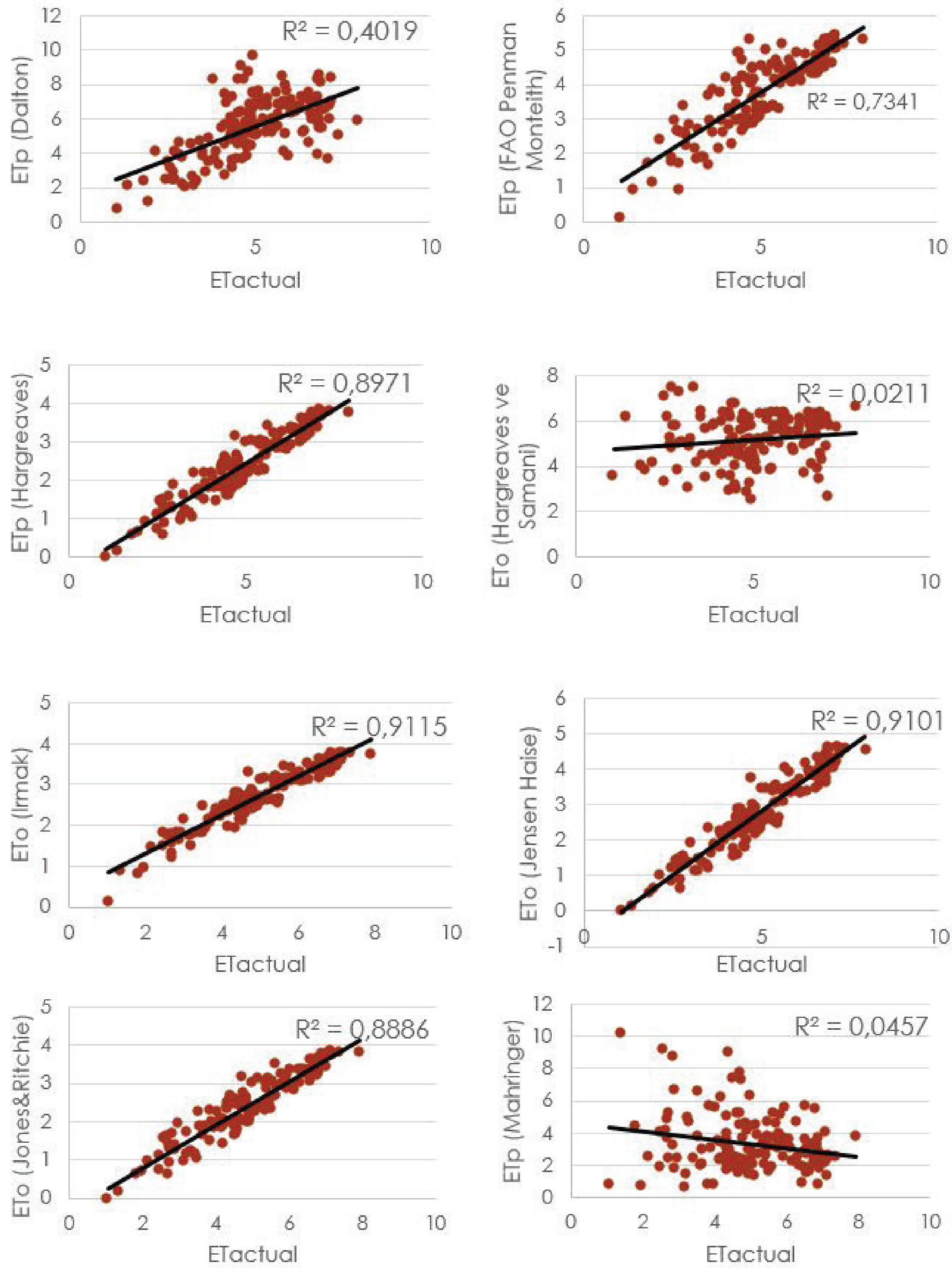

Figure 5 (continued). Scatter plots of calculated and measured ET.

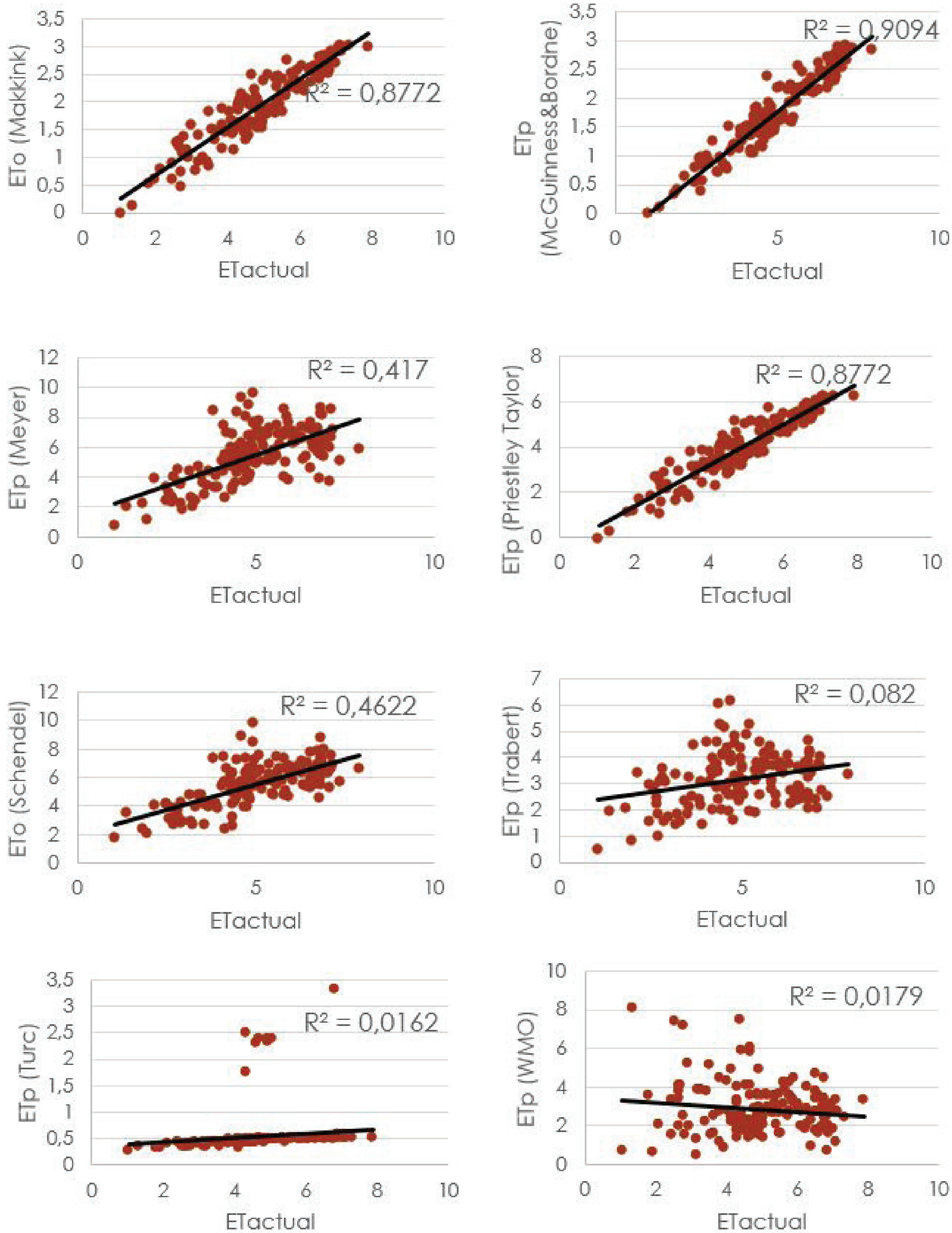

Figure 5 (continued). Scatter plots of calculated and measured ET.