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Monthly and fixed coefficient calibration of empirical reference evapotranspiration equations: A case study for a Mediterranean climate (Izmir Province)

Birol Kaya[1*], Maryam Adhami[2], Ceren Ustabaş[3], Amin Gharehbaghi[4], Ehsan Afaridegan[5]

[1] Department of Civil Engineering, Faculty of Engineering, Dokuz Eylül University, Izmir, Türkiye.
[2] Department of Watershed Management Engineering, Faculty of Natural Resources, Tarbiat Modares University, Noor, Mazandaran, Iran.
[3] Department of Civil Engineering, Faculty of Engineering, Dokuz Eylül University, Izmir, Türkiye.
[4] Department of Civil Engineering, Faculty of Engineering, Hasan Kalyoncu University, Gaziantep, Türkiye.
[5] Department of Civil Engineering, Faculty of Engineering, Yazd University, Yazd, Iran.
[*] Corresponding author. E-mail: birol.kaya@deu.edu.tr

Abstract: Accurate estimation of reference evapotranspiration (ET_0) is essential for efficient irrigation and water resource management, particularly in water-scarce regions. Although the FAO56 Penman–Monteith (PM-FAO56) equation is widely accepted as the standard method, its application is often constrained by the requirement for comprehensive meteorological data. This study provides a regional evaluation and calibration of three widely used empirical ET_0 models Hargreaves and Samani (temperature-based), Priestley and Taylor (radiation-based), and Mahringer (mass transfer-based) under Mediterranean climatic conditions in İzmir, Türkiye. Daily meteorological data from 40 stations covering the period 2000–2020 were used. Model performance was assessed against PM-FAO56 using the coefficient of determination (R^2), mean absolute error (MAE), root mean square error (RMSE), percentage error (PE), Nash–Sutcliffe efficiency (NSE) and mean bias error (MBE). Calibration was performed using least squares (LS) regression and a gradient-based optimization approach, with both fixed and monthly varying coefficients. Before calibration, the Priestley–Taylor model showed the best performance among the empirical equations (R^2 = 0.932, MAE = 0.68, RMSE = 0.92, PE = 7.32, NSE=0.796, MBE=-0.65). After calibration, all models improved substantially, with the Mahringer equation achieving the highest accuracy when monthly coefficients were applied (R^2 = 0.995, MAE = 0.05, RMSE = 0.154, PE = 1.41, NSE=0.992, MBE=0.022). The LS and gradient-based optimization approaches produced nearly identical results. In addition, the reconstruction of missing sunshine duration (ADS) data using a regression-based approach enabled the inclusion of a more spatially representative dataset without introducing significant bias into the calibration results. The findings demonstrate that locally calibrated empirical equations, particularly when temporal variability is accounted for through monthly coefficients, can provide highly accurate ET_0 estimates with relatively limited data requirements. This study provides practical monthly and fixed calibration coefficients for the İzmir region and supports the use of monthly calibrated empirical models for irrigation planning in Mediterranean environments.

Keywords: Reference evapotranspiration; Calibration; Water management; Mediterranean climate.

1 INTRODUCTION

In recent decades, rapid population growth and increasing food demand have intensified pressure on natural resources, particularly freshwater, with agriculture accounting for nearly 70% of global freshwater consumption (FAO, 2023; Pereira, 2017). This challenge is further exacerbated by climate change, which alters precipitation patterns, increases temperature variability, and intensifies drought conditions, especially in arid and semi-arid regions (IPCC, 2022; Irmak et al., 2012; Bodian et al., 2020). Under these conditions, efficient water management and irrigation scheduling have become critical for sustainable agricultural production. A key component of such management strategies is the accurate estimation of evapotranspiration (ET), which directly governs crop water requirements and water use efficiency (Moratiel et al., 2020).

Reference evapotranspiration (ET_0) represents the evapotranspiration from a standardized reference surface and serves as the basis for estimating crop water demand. It plays a fundamental role in hydrological processes, irrigation planning, and water resource management (Awal et al., 2020). ET_0 can be determined either through direct measurements (e.g., lysimeters, eddy covariance systems) or through indirect estimation methods based on meteorological data. Although direct measurements are considered highly reliable, they are often expensive, labor-intensive, and difficult to maintain over long periods (Gocic and Trajkovic, 2014). Consequently, estimation methods have become widely used in practical applications.

Among these, the FAO56 Penman–Monteith (PM-FAO56) equation is widely accepted as the standard method for ET_0 estimation due to its strong physical basis (Allen et al., 1998; Walter et al., 2000). However, its application is often limited by the requirement for multiple meteorological inputs, including radiation, humidity, wind speed, and temperature, which are not always available in many regions (Tabari, 2010). To address this limitation, empirical ET_0 estimation methods are commonly classified based on the climatic variables they employ, including temperature-based, radiation-based, mass transfer-based, and combination methods (Jensen et al., 1990; Oudin, 2004; Valiantzas, 2013). Several empirical equations developed from these categories such as Hargreaves and Samani, Priestley and Taylor, and Mahringer have been widely adopted due to their simplicity and low data requirements (Hargreaves and Samani, 1985; Priestley and Taylor, 1972; Mahringer, 1970). However, their performance is highly sensitive to local climatic conditions, and uncalibrated applications may lead to significant estimation errors (Ndiaye et al., 2020; Djaman et al., 2015). Therefore, calibration and validation are essential to ensure their reliability under different environmental conditions (Howes et al., 2015) .

Numerous studies have investigated the calibration and performance of empirical ET_0 equations across different climatic regions. Earlier studies have emphasized the necessity of local calibration to improve model accuracy under varying climatic conditions (Almorox et al., 2015; Djaman et al., 2015). For example, Cobaner et al. (2017) calibrated the Hargreaves–Samani equation for Türkiye using regional coefficients, while Bourletsikas et al. (2018) highlighted the importance of calibration for mass transfer–based models in Mediterranean environments. Similarly, Farzanpour et al. (2019) and Celestin et al. (2020) demonstrated that calibration significantly improves model performance across different climatic conditions. In addition, Gharehbaghi and Kaya (2022a, 2022b) and Gharehbaghi et al. (2024) investigated the calibration of empirical ET_0 equations for different climatic regions of Türkiye using both conventional and advanced optimization approaches. These findings are consistent with studies emphasizing the importance of regional calibration and evaluation of empirical ET_0 equations under diverse climatic conditions (Azzam et al., 2023; Koç, 2022; Heydari et al., 2014a, 2014b). These studies generally rely on regression-based methods and often employ fixed annual coefficients, which may not adequately capture seasonal variability.

In parallel with these developments, machine learning (ML) and deep learning (DL) techniques have increasingly been applied to ET_0 estimation, particularly in data-scarce environments. Recent studies have demonstrated that ML models such as artificial neural networks, random forests, and ensemble approaches can effectively capture nonlinear relationships among climatic variables and improve ET_0 estimation accuracy (Považanová et al., 2023; Granata et al., 2024; Chen et al., 2020; Babaeian et al., 2022). Earlier comparative studies also showed that ML-based approaches can outperform empirical equations under certain conditions (Landeras et al., 2008). In Mediterranean and European climates, ML-based approaches have shown notable improvements over traditional temperature-based equations. For instance, Bellido-Jiménez et al. (2021, 2022, 2023) reported that ML models outperform conventional methods in Southern Spain, while Di Nunno and Granata (2023) highlighted their effectiveness under Mediterranean climate conditions using climate projection data. Furthermore, Ye et al. (2025) demonstrated the potential of transfer and deep learning approaches for large-scale ET_0 estimation.

Despite these advantages, ML and DL approaches also present several well-documented limitations. These include the risk of overfitting, dependence on large and high-quality datasets, reduced interpretability (black-box nature), and challenges in transferring models across regions with different climatic conditions, particularly where strong seasonality in radiation, temperature, and humidity patterns exists (Landeras et al., 2008; Granata et al., 2024; Bellido-Jiménez et al., 2022). Such limitations may restrict their direct applicability in operational water management, especially in regions with limited data availability or where model transparency is required.

In contrast, empirical equations remain attractive due to their simplicity, transparency, and low data requirements. When properly calibrated, these models can provide reliable ET_0 estimates while maintaining physical interpretability and ease of implementation. Therefore, rather than replacing empirical models, recent research increasingly highlights the importance of improving their performance through robust calibration strategies.

Despite the extensive literature on both empirical calibration and ML/DL-based ET_0 estimation, there remains a need for robust, transparent, and practically applicable calibration strategies, particularly under data-limited conditions in Mediterranean climates where strong seasonal variability exists.

In this context, the present study provides a comprehensive and applied evaluation of empirical ET_0 calibration under Mediterranean climatic conditions in the İzmir region. Specifically, the study (i) compares temperature, radiation, and mass transfer based empirical equations, (ii) evaluates the performance of monthly versus fixed calibration coefficients using data from 40 meteorological stations, (iii) examines least squares (LS) and gradient-based (GB) optimization approaches as parameter estimation tools, and (iv) assesses the robustness of calibration results under missing data conditions.

Calibration was performed using both LS regression and a gradient-based optimization framework. The gradient-based approach was included to provide a flexible optimization framework that can be extended to more complex or constrained calibration problems and was primarily used as an alternative parameter estimation method for linear calibration relationships. Model performance was evaluated against the FAO56 Penman–Monteith method, which was adopted as the reference.

2 MATERIALS AND METHODS

2.1 Study area and data preparation

Izmir Province is located in the Western Anatolia Region of Türkiye and covers an area of 11,891 km². It is bordered by Manisa Province to the north and east and the Aegean Sea to the west. The region has a Mediterranean climate characterized by hot, dry summers and mild, rainy winters, with annual precipitation ranging between 700 and 1200 mm (Köppen climate classification: Csa). Figure 1 illustrates the study area and the locations of the synoptic meteorological stations used in this study.

Fig. 1. Location of the study area and synoptic stations.

This study utilized meteorological data obtained from 40 synoptic stations distributed across Izmir Province. Data from 20 stations were employed for model calibration, while the remaining 20 stations were reserved for validation. The selection of calibration and validation stations was carried out by considering their spatial distribution across the study area to ensure representative coverage of varying topographic and climatic conditions. In particular, care was taken to avoid clustering of stations in specific areas, and stations were selected to represent both coastal locations and inland regions. Daily observations covering the period 2000–2020 included minimum, maximum, and mean air temperature, minimum, maximum, and mean relative humidity, wind speed measured at 2 m height, and actual duration of sunshine.

Although long-term climatic records were available for all stations, actual duration of sunshine (ADS) data were missing at some locations. Due to the strong correlation between actual duration of sunshine and air temperature, missing ADS values were estimated using a regression-based approach. Table 1 provides the station numbers, locations, coordinates, altitudes, and observation years, as well as the years and percentages of missing ADS data. The percentage of missing ADS data varied among stations. It was observed that missing ADS data was particularly higher at newly established stations.

The relatively high proportion of missing ADS data, particularly in stations established within the last 15-20 years, can be attributed to differences in instrumentation and data acquisition priorities. Unlike temperature or humidity, sunshine duration requires either specialized sensors or indirect estimation from radiation measurements, which are not consistently available across all stations. Additionally, quality control procedures and shorter operational periods contribute to increased data gaps in newer stations. This limitation highlights the practical challenges of applying radiation-based ET_0 estimation methods in data-scarce environments and supports the need for robust calibration of simpler empirical models.

As summarized in Table 1, actual duration of sunshine (ADS) data were complete at 7 stations, while the data missing rate at stations with incomplete ADS data ranged from 18% to 100%, averaging approximately 67.5%. Some stations, particularly those with shorter observation times, had a relatively high missing data rate. However, these stations were retained in the analysis to maintain the spatial representability of the dataset. While missing data were reconstructed using regression-based methods, their potential impact on ET_0 estimation and calibration results is not assessed at this stage but is systematically evaluated in the subsequent Results and Discussion sections.

2.2 Evapotranspiration estimation

2.2.1 Reference Evapotranspiration: FAO56 Penman-Monteith formula

Reference evapotranspiration (ET_0) was calculated using the FAO56 Penman–Monteith method following the standard procedures described by Allen et al. (1998).

$$ET_0 = \frac{0.408\Delta(R_n - G) + \gamma\frac{900}{T+273}U_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34U_2)} \quad (1)$$

where ET_0 is the reference evapotranspiration (mm day^{-1}), Δ is the slope of the saturation vapor pressure curve (kPa °C^{-1}), R_n is the net radiation (MJ m^{-2} day^{-1}), G is the soil heat flux (MJ m^{-2} day^{-1}), T is the mean air temperature (°C), U_2 is the wind speed at 2 m height (m s^{-1}), e_s and e_a are the saturation and actual vapor pressures (kPa), respectively, and γ is the psychrometric constant (kPa °C^{-1}). In this study, soil heat flux (G) was assumed to be zero. The method integrates the effects of net radiation, air temperature, wind speed, and vapor pressure deficit to estimate evapotranspiration from a hypothetical reference crop.

Net radiation was computed using available solar radiation data, and where necessary, radiation-related parameters were derived using standard FAO56 relationships. Saturation vapor pressure and actual vapor pressure were calculated from air temperature and relative humidity data using established formulations. Wind speed data were used as recorded, as all measurements were available at the standard height of 2 m, and therefore no height adjustment was required.

All required physical constants, including the psychrometric constant and the slope of the saturation vapor pressure curve, were determined according to FAO56 guidelines. The calculations were performed on a daily basis for all stations to provide a consistent reference dataset for model calibration and evaluation. This standardized computation ensures comparability between stations and provides a reliable reference for evaluating empirical ET_0 models.

The other empirical ET_0 equations (Hargreaves-Samani, Priestley-Taylor, and Mahringer) were applied using the same source meteorological dataset, following the respective standard formulations described above. All calculations were performed on a daily basis and consistently across all stations. This unified approach ensures comparability among methods and provides a reproducible reference dataset for evaluating the performance of empirical ET_0 models.

2.2.2 The Hargreaves and Samani formula

The Hargreaves and Samani (1985) temperature-based method was used to estimate ET_0 as follows:

$$ET_0 = 0.408\, C_{HS} R_a (T_a + 17.8)\sqrt{T_{max} - T_{min}} \quad (2)$$

where T_{max} and T_{min} are the maximum and minimum air temperatures (°C), T_a is the mean air temperature (°C), and R_a is the extraterrestrial radiation (MJ m^{-2} day^{-1}). The coefficient C_{HS}, originally suggested as 0.0023, was recalibrated to reflect local climatic conditions. Extraterrestrial radiation was calculated using:

$$R_a = \frac{24 \times 60}{\pi} G_{SC} d_r [\omega_s \sin(\varphi)\sin(\delta) + \cos(\varphi)\cos(\delta)\sin(\omega_s)] \quad (3)$$

where G_{sx} is the solar constant (0.082 MJ m^{-2} min^{-1}), φ is latitude (rad), ω_s is the sunset hour angle (rad), δ is the solar declination (rad), and d_r is the inverse relative Earth–Sun distance (Allen et al., 1998).

2.2.3 The Priestley and Taylor formula

The radiation-based Priestley and Taylor (1972) equation was applied as:

$$ET_0 = \alpha \frac{\Delta}{\Delta + \gamma} \frac{R_n - G}{\lambda} \quad (4)$$

where λ is the latent heat of vaporization (MJ kg^{-1}), and other parameters are defined as in previous equations.

2.2.4 Mahringer formula

The mass transfer–based Mahringer equation was expressed as:

$$ET_0 = 2.86 U^{0.5}(e_s - e_a) \quad (5)$$

where U is the wind speed at 2 m height (m s^{-1}), and e_s and e_a are the saturation and actual vapor pressures (kPa), respectively (Mahnringer, 1970).

Table 1. Specifications of the study synoptic stations, including coordinates, elevation, observation periods, and missing actual duration of sunshine (ADS) data.

Station Number	City	Latitude	Longitude	Elevation (m)	Available data	Missing ADS data: years and percentage	
9020	Menemen	38.5833	27.0666	10	1961-1995	-	0
17180	Dikili	39.0737	26.888	3	1960-2020	1960-1965	27
17218	Çiğli	38.5127	27.0144	5	2009-2020	2009-2012	18
17219	Gaziemir	38.2950	27.1481	120	2001-2020	2001-2011	55
17220	Konak	38.3949	27.0819	29	1960-2020	-	0
17221	Çeşme	38.3036	26.3724	5	1963-2020	-	0
17383	Narlıdere	38.4256	26.9133	2	2013-2020	2013-2020	100
17384	Urla	38.4467	26.7175	7	2013-2020	2013-2020	100
17439	Foça	38.6194	26.7447	8	2013-2020	2013-2020	100
17440	Urla	38.3658	26.7733	6	2013-2020	2013-2020	100
17441	Güzelbahçe	38.3794	26.8861	12	2013-2020	2013-2020	100
17442	Konak	38.4303	27.1322	6	2013-2020	2013-2020	100
17443	Çeşme	38.3303	26.2683	7	2013-2020	2013-2020	100
17444	Karaburun	38.5189	26.6283	8	2013-2020	2013-2020	100
17742	Bergama	39.1098	27.171	53	1963-2020	1963-1983, 2008, 2013-2020	48
17749	Kemalpaşa	38.4639	27.3705	208	2010-2020	-	0
17782	Foça	38.6856	26.7392	37	2009-2020	2009-2013,2015-2020	92
17787	Aliağa	38.7922	26.9682	27	2007-2020	2007-2011,2016-2020	71
17789	Menemen	38.6237	27.0433	10	2007-2020	-	0
17790	Bornova	38.4666	27.2166	27	1963-2006	-	0
17822	Ödemiş	38.2157	27.9642	111	1960-2020	1960-2004, 2013-2020	85
17854	Selçuk	37.9423	27.3669	18	1964-2020	1964-1983, 2013-2020	76
18028	Urla	38.3628	26.8322	60	2012-2020	2012,2014, 2016-2020	67
18030	Torbalı	38.1743	27.3623	60	2012-2020	2012, 2014, 2016-2020	67
18031	Bornova	38.4517	27.1979	14	2012-2020	-	0
18032	Karaburun	38.6401	26.5081	132	2012-2020	2012,2014,2016-2020	67
18034	Cumaovası	38.2447	27.0849	145	2012-2020	2012,2014,2016-2020	67
18035	Urla	38.2836	26.577	149	2012-2020	2012,2014,2016-2020	67
18038	Aliağa	38.7175	26.9613	144	2012-2020	2012,2014,2016-2020	67
18049	Bayındır	38.1975	27.6719	70	2012-2020	2012,2014,2016-2019	67
18050	Cumaovası	38.0720	27.0026	70	2012-2020	2012,2014-2020	89
18441	Beydağ	38.0872	28.2233	215	2014-2020	2014-2020	100
18443	Buca	38.3750	27.1953	150	2014-2020	2014-2020	100
18444	Güzelbahçe	38.3717	26.8908	20	2014-2020	2014,2016-2019	71
18445	Karabağlar	38.3106	27.0006	965	2014-2020	2014-2020	100
18446	Karşıyaka	38.4811	27.0322	2	2014-2020	2014-2020	100
18447	Kiraz	38.2192	28.2028	310	2014-2020	2014-2020	100
18448	Konak	38.4049	27.1895	283	2014-2020	2014-2020	100
18450	Narlıdere	38.3842	27.0044	240	2014-2020	2014-2020	100
18901	Dikili	39.1956	26.9606	643	2014-2020	2014-2020	100

2.3 Calibration procedure of Empirical Models

Calibration of empirical ET_0 equations was performed to reduce estimation errors by adjusting model coefficients. Both a single annual coefficient and monthly varying coefficients were considered to account for intra-annual variability. Calibration was conducted using the following formulations:

$$ET_{0,Calibrated\ Empirical} = K\ ET_{0,Empirical} \quad (6)$$

$$ET_{0,Calibrated\ Empirical} = A + B\ ET_{0,Empirical} \quad (7)$$

where K, A, and B are calibration coefficients determined separately for each month using monthly mean ET_0 values.

To calculate the coefficients in Equations 6 and 7, the least squares (LS) and gradient-based optimization (GB) approaches were used. The minimized cost function during optimization was defined as follows:

$$J(a,b) = \frac{1}{2n}\sum_{i=1}^{n}(y_{pred,i} - y_i)^2 \quad (8)$$

where $y_{pred,i} = a + bx_i$ represents the predicted ET_0 and y_i is the PM-FAO56 reference ET_0.

Gradient based optimization updates were performed as:

$$a = a - \alpha \frac{\partial}{\partial a} J(a,b) \quad (9)$$

$$b = b - \alpha \frac{\partial}{\partial b} J(a,b) \quad (10)$$

The same cost function was used for both LS and GB optimization approaches to ensure consistency in model comparison.

In addition to the least squares (LS) approach, a gradient-based (GB) optimization framework was implemented to estimate the calibration coefficients. This framework was formulated using a simple feedforward neural network with one hidden layer consisting of 10 neurons and ReLU activation function. The network was not designed to develop a standalone nonlinear predictive model, but rather to serve as a flexible computational tool for minimizing the defined cost function through iterative gradient descent updates. This minimal architecture was selected after preliminary tests, as more complex structures (additional layers or higher number of neurons) did not improve the quality of the estimated coefficients. The neural-network structure was used only as a computational optimization framework rather than to exploit nonlinear predictive capability. ReLU activation was chosen for its computational efficiency and stable convergence; sigmoid and tanh functions were also tested but offered no advantage. Given the predominantly linear nature of the calibration equations, the GB optimization approach effectively functions as an alternative parameter estimation method comparable to conventional least squares regression.

2.4 Performance comparison criteria

Model performance was evaluated using the coefficient of determination (R^2), mean absolute error (MAE), root mean square error (RMSE), percentage error (PE), Nash–Sutcliffe efficiency (NSE), and mean bias error (MBE).

$$R^2 \frac{\left[\sum_{i=1}^{n}(P_i-\bar{P})(O_i-\bar{O})\right]^2}{\sum_{i=1}^{n}(P_i-\bar{P})^2\sum_{i=1}^{n}(O_i-\bar{O})^2} \quad (11)$$

$$MAE = \frac{\sum_{i=1}^{n}|P_i - O_i|}{n} \quad (12)$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(P_i - O_i)^2}{n}} \quad (13)$$

$$PE = \left|\frac{\bar{P}-\bar{O}}{\bar{O}}\right| \times 100\% \quad (14)$$

$$NSE = 1 - \frac{\sum_{i=1}^{n}(P_i - O_i)^2}{\sum_{i=1}^{n}(O_i - \bar{O})^2} \quad (15)$$

$$MBE = \frac{\sum_{i=1}^{n}(P_i - O_i)}{n} \quad (16)$$

where P_i and O_i denote estimated and observed ET_0 values, respectively, and n is the number of observations.

The overall workflow of the study, including data preparation, completion of missing data, ET_0 calculation, model calibration, and performance evaluation, is presented in Supplementary Document S1.

3 RESULTS

3.1 Estimation and validation of actual duration of sunshine

In the study region, some records of actual duration of sunshine (ADS) were missing, particularly in stations with shorter observation periods. A strong relationship was identified between ADS and average air temperature (T_a), which was used as the basis for estimating missing values.

A linear regression model was developed using data from Station 9020, which provides a continuous 30-year record of both variables. The resulting equation is expressed as:

$$ADS = 1.1596 + 0.37808\, T_a \quad (17)$$

Table 2. Error metrics for actual duration of sunshine (ADS) estimation.

Station	R2	MAE	RMSE	MBE	NSE
9020	0.82	0.29	1.25	0.02	0.99
17180	0.71	1.02	1.88	0.19	0.88
17218	0.75	1.53	1.34	1.49	0.78
17219	0.85	1.52	1.16	1.44	0.79
17220	0.84	0.47	1.20	-0.03	0.98
17221	0.80	1.60	1.38	1.24	0.76
17742	0.81	2.13	1.26	1.89	0.65
17749	0.70	0.19	1.89	0.14	0.98
17789	0.55	0.24	2.26	0.16	0.98
17790	0.84	0.34	1.23	0.09	0.99
17822	0.84	3.31	1.36	3.23	0.57
17854	0.78	2.00	1.30	1.79	0.66
18031	0.84	0.17	1.26	0.14	0.98
Average	0.78	1.21	1.46	0.98	0.83

The model demonstrated a strong correlation ($R^2 = 0.8164$), indicating that air temperature is a reliable predictor of ADS in the study area.

The regression model was independently validated using 12 stations with partially available ADS observations. As summarized in Table 2, R^2 values ranged from 0.55 to 0.84, with an average of 0.78, while the average NSE was 0.83. The mean MAE and RMSE values were 1.21 and 1.46 h, respectively, and the average MBE was 0.98 h, indicating acceptable estimation accuracy with limited systematic bias.

Residual analysis presented in Supplementary Figure S1 showed that residuals were generally distributed around zero without a clear trend, indicating stable model performance across different ADS ranges.

To evaluate the effect of ADS reconstruction on ET_0 calibration, two scenarios were compared:

(i) using only stations with complete ADS observations, and

(ii) using the full dataset including reconstructed ADS values.

Station-based error metrics for both scenarios are presented in Supplementary Table S1. The comparison showed only minor differences in model performance (approximately ±1%), with no change in model ranking or overall conclusions.

Excluding stations with missing ADS data would substantially reduce the usable meteorological dataset. Therefore, reconstructed ADS values were included to improve spatial representativeness while maintaining acceptable accuracy.

To illustrate the effect of ADS availability on calibration performance, two representative stations were selected: station 17789 with complete ADS observations and station 17440 with reconstructed ADS data. Figures 2–5 present the empirical equations and scatter plots of ET_0 values calculated using PM-FAO56 and calibrated empirical equations for these stations, with calibrations performed both with and without reconstructed ADS data. Scatter plots obtained using only stations with measured ADS data are presented for all stations in Supplementary Figure S2.

The results indicate that inclusion of reconstructed ADS data does not significantly affect calibration performance or the overall conclusions of the study.

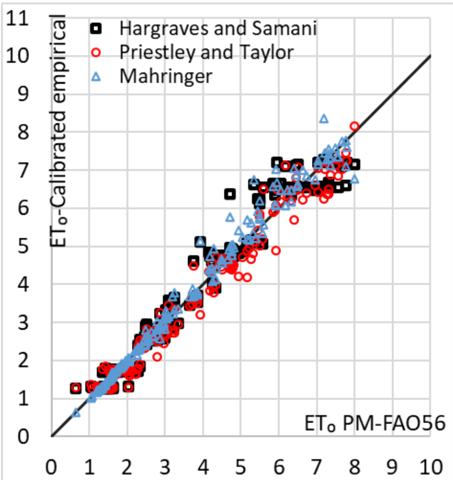


Fig. 2. PM-FAO56 and calibrated empirical equations ET_0 values ET_0 for station 17789 (calibration coefficients were calculated by completing the data of stations with missing ADS data and including them in the calibration)

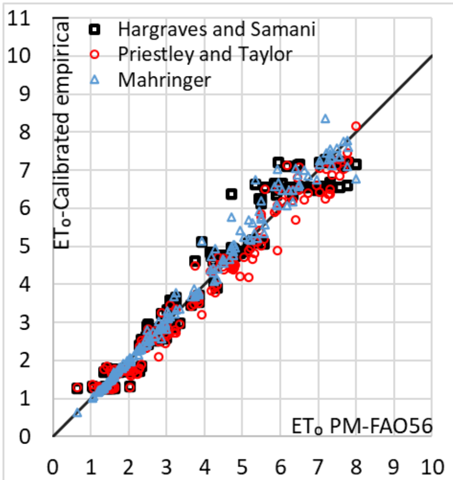


Fig. 3. PM-FAO56 and calibrated empirical equations ET_0 values for station 17789 (calibration coefficients were calculated by including only stations with available ADS data in the calibration).

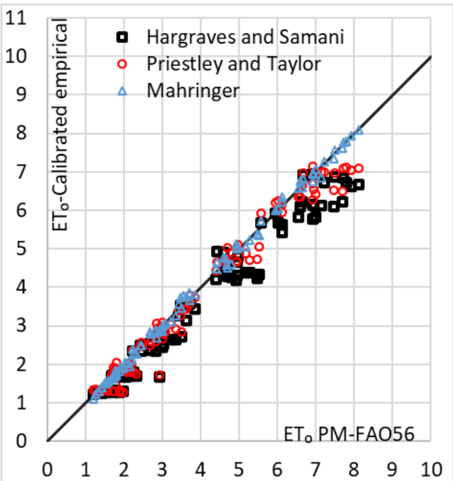


Fig. 4. PM-FAO56 and calibrated empirical equations ET_0 values for station 17440 (calibration coefficients were calculated by completing the data of stations with missing ADS data and including them in the calibration)

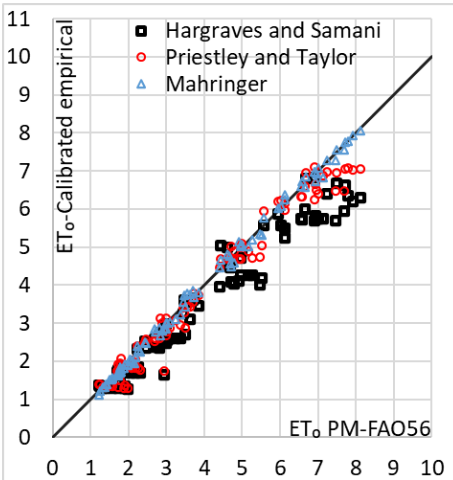


Fig. 5. PM-FAO56 and calibrated empirical equations ET_0 values for station 17440 (calibration coefficients were calculated by including only stations with available ADS data in the calibration).

3.2 Calibration and performance evaluation of empirical Evapotranspiration equations

The PM-FAO56 method was used as the reference for calibrating the selected empirical ET_0 equations. Calibration coefficients (K, A, and B) were determined using both least squares (LS) and a gradient-based optimization approach. Monthly calibration coefficients (K_m, A_m, B_m) were obtained through separate calibration for each month, while fixed coefficients (K, A, B) were derived from the complete dataset.

The monthly coefficients for the Hargreaves and Samani (HAS), Priestley and Taylor (PRT), and Mahringer (MAH) equations are presented in Table 3, and the fixed coefficients are given in Table 4. In Table 3, K_m represents the monthly multiplicative coefficient for Equation (6), while A_m and B_m are the monthly coefficients for the linear correction in Equation (7). Table 4 presents the corresponding fixed (annual) coefficients (K, A, B) derived from the complete dataset. Performance comparisons between original and calibrated equations are summarized in Table 5.

A comparison between calibration Equations (6) and (7) indicates that the linear correction approach using A and B coefficients consistently outperformed the multiplicative K-based calibration. Monthly calibration using A_mB_m coefficients yielded the highest accuracy for all empirical equations, regardless of the calibration method employed.

For the Hargreaves and Samani equation, R^2 values increased from 0.909 (original) to 0.952 using A_mB_m coefficients. Similarly, R^2 increased from 0.932 to 0.953 for the Priestley and Taylor equation and from 0.918 to 0.995 for the Mahringer equation. As shown in Table 5, these improvements are consistently supported by reductions in MAE, RMSE, and PE values. In addition, the NSE values increased significantly, indicating improved model efficiency, while MBE values approached zero, suggesting a reduction in systematic bias.

Table 3. Monthly calibration coefficients using Least squares and Gradient Based methods in Izmir Province.

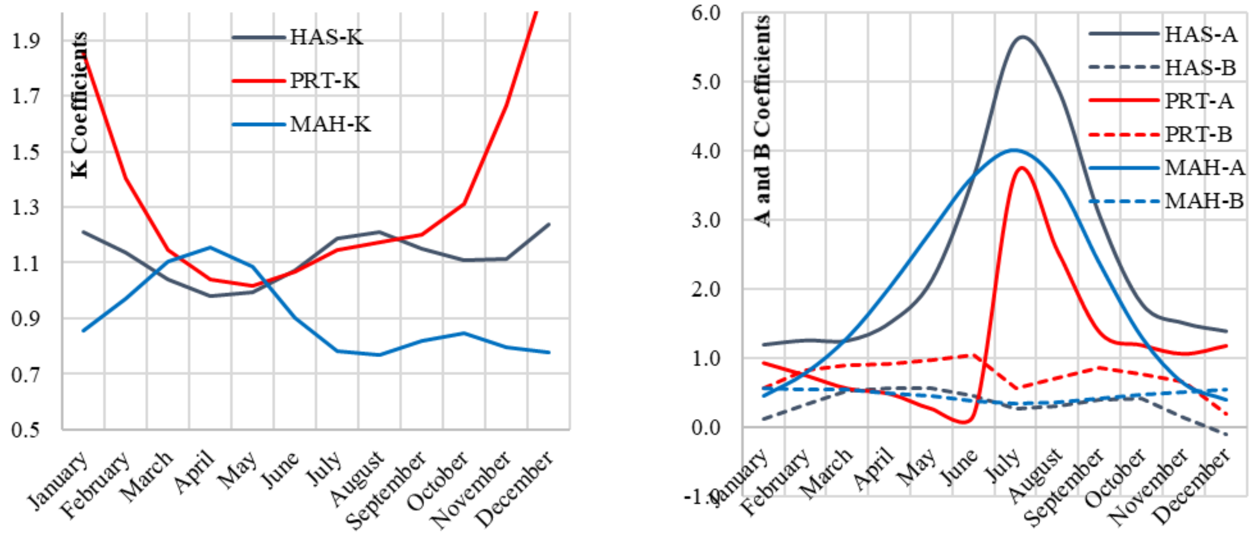
			Monthly coefficients											
			January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Least squares(LS)	HAS	Km	1.209	1.139	1.038	0.979	0.992	1.073	1.187	1.212	1.152	1.107	1.116	1.239
		Am	1.192	1.255	1.253	1.508	2.129	3.634	5.592	4.890	3.042	1.779	1.504	1.388
		Bm	0.105	0.321	0.516	0.559	0.554	0.449	0.253	0.298	0.399	0.414	0.136	-0.111
	PRT	Km	1.853	1.402	1.148	1.040	1.015	1.069	1.148	1.172	1.201	1.310	1.667	2.146
		Am	0.918	0.738	0.546	0.471	0.252	0.173	3.667	2.529	1.357	1.176	1.050	1.167
		Bm	0.551	0.810	0.897	0.901	0.962	1.039	0.555	0.715	0.851	0.769	0.645	0.180
	MAH	Km	0.856	0.972	1.103	1.154	1.084	0.903	0.783	0.769	0.817	0.845	0.797	0.777
		Am	0.445	0.779	1.295	2.023	2.849	3.639	4.009	3.533	2.353	1.288	0.621	0.387
		Bm	0.564	0.539	0.530	0.491	0.443	0.377	0.341	0.350	0.404	0.462	0.508	0.541
Gradient Based (GB)	HAS	Km	1.143	1.082	1.003	0.955	0.972	1.051	1.158	1.183	1.120	1.062	1.053	1.168
		Am	0.425	0.605	0.706	0.819	0.998	1.354	1.780	1.613	1.275	0.945	0.664	0.427
		Bm	0.791	0.724	0.731	0.741	0.777	0.827	0.870	0.892	0.818	0.721	0.658	0.797
	PRT	Km	1.782	1.367	1.134	1.034	1.014	1.068	1.144	1.167	1.191	1.277	1.596	2.037
		Am	0.423	0.404	0.382	0.382	0.353	0.383	0.637	0.636	0.624	0.679	0.555	0.489
		Bm	1.240	1.068	0.969	0.926	0.942	1.004	1.041	1.054	1.035	0.986	1.109	1.310
	MAH	Km	0.764	0.838	0.934	0.981	0.941	0.800	0.706	0.689	0.730	0.747	0.705	0.697
		Am	0.421	0.740	1.227	1.881	2.566	3.169	3.368	3.057	2.103	1.204	0.598	0.373
		Bm	0.576	0.555	0.552	0.526	0.493	0.432	0.399	0.396	0.439	0.481	0.516	0.547

Table 4. Fixed calibration coefficients using Least squares and Gradient Based methods in Izmir Province.

Least squares(LS)									**Gradient Based (GB)**								
HAS			**PRT**			**MAH**			**HAS**			**PRT**			**MAH**		
K	**A**	**B**	**K**	**A**	**B**	**K**	**A**	**B**	**K**	**A**	**B**	**K**	**A**	**B**	**K**	**A**	**B**
1.111	0.344	1.008	1.179	0.565	0.999	0.877	1.228	0.586	1.084	0.348	1.007	1.124	0.555	1.001	0.754	1.215	0.588

Table 5. Performance metrics of Evapotranspirations estimates using calibrated coefficients.

		Km(LS)	K (LS)	AmBm(LS)	AB (LS)	Km(GB)	K (GB)	AmBm(GB)	AB(GB)	Original equation
Hargreaves and Samani	R2	0.941	0.909	0.952	0.908	0.941	0.926	0.948	0.909	0.909
	MAE	0.575	0.574	0.371	0.541	0.609	0.507	0.494	0.538	0.725
	RMSE	0.847	0.935	0.648	0.949	0.871	0.852	0.765	0.947	1.063
	PE	15.152	15.121	9.726	14.184	15.939	13.318	12.823	14.127	18.757
	NSE	0.803	0.775	0.893	0.773	0.792	0.813	0.847	0.775	0.706
	MBE	-0.240	-0.238	-0.153	-0.218	-0.345	-0.214	-0.260	-0.223	-0.592
Priestley and Taylor	R2	0.948	0.932	0.953	0.931	0.948	0.940	0.950	0.932	0.932
	MAE	0.308	0.307	0.301	0.304	0.316	0.315	0.305	0.301	0.676
	RMSE	0.618	0.738	0.600	0.683	0.622	0.658	0.612	0.682	0.919
	PE	8.292	8.259	8.050	8.137	8.454	8.393	8.149	8.068	17.319
	NSE	0.885	0.842	0.894	0.870	0.885	0.879	0.889	0.871	0.796
	MBE	-0.075	-0.087	-0.095	-0.084	-0.114	-0.116	-0.097	-0.089	-0.648
Mahringer	R2	0.947	0.918	0.995	0.917	0.950	0.952	0.994	0.918	0.918
	MAE	0.352	0.356	0.050	0.149	0.336	0.168	0.054	0.150	0.779
	RMSE	0.723	0.988	0.154	0.685	0.612	0.481	0.162	0.680	1.452
	PE	9.280	9.369	1.408	3.925	9.575	4.719	1.490	3.963	19.872
	NSE	0.867	0.774	0.992	0.883	0.882	0.921	0.992	0.885	0.527
	MBE	0.168	0.170	0.022	0.081	-0.292	0.012	-0.007	0.081	0.723



(a) (b)

Fig. 6. (a) Monthly K coefficients and (b) monthly A and B coefficients for the empirical equations.

To further examine the influence of temporal variability on calibration performance, the behavior of monthly and fixed calibration coefficients was evaluated. Figure 6 illustrates the monthly variation of the calibrated coefficients for the empirical equations, revealing clear and systematic patterns throughout the year.

For the K coefficient (Fig. 6a), the Priestley–Taylor method exhibits pronounced month-to-month variability, with lower values in specific months and a sharp increase towards the winter months. In contrast, the Hargreaves–Samani method shows relatively stable behavior, whereas the Mahringer method displays an opposite pattern, with higher values during late winter and spring and lower values during summer.

For the A and B coefficients (Fig. 6b), strong month-to-month variability is evident, particularly for the Hargreaves–Samani and Priestley–Taylor equations. The A coefficients generally peak during the summer months (June–August), corresponding to periods of higher evaporative demand, whereas the B coefficients show comparatively smaller variation, indicating a more stable baseline adjustment.

These findings indicate that calibration parameters vary systematically throughout the year under changing climatic conditions. Accordingly, the use of monthly calibration coefficients (K_m and A_mB_m) resulted in consistently better performance than fixed coefficients (K and AB), with improvements of approximately 0.02–0.05 in R^2 and substantial reductions in error metrics. In addition to the comparison of calibration formulations, the performance of the LS and GB coefficient estimation approaches was also evaluated. No substantial differences were observed between the LS and GB methods for estimating calibration coefficients due to the linear nature of the calibration relationships. Consequently, coefficients obtained using either method are suitable for ET_0 estimation.

Table 6. Station-based performance metrics of Hargreaves–Samani and Priestley–Taylor equations using Am and Bm (LS) calibration.

	Hargreaves and Samani						Priestley and Taylor					
Station	**R2**	**MAE**	**RMSE**	**PE**	**NSE**	**MBE**	**R2**	**MAE**	**RMSE**	**PE**	**NSE**	**MBE**
9020	0.931	0.092	0.565	2.355	0.921	-0.092	0.938	0.245	0.564	6.258	0.921	-0.245
17180	0.965	0.261	0.454	7.959	0.939	0.261	0.971	0.456	0.632	13.893	0.882	0.456
17218	0.964	0.415	0.660	9.967	0.923	-0.415	0.970	0.545	0.765	13.079	0.896	-0.545
17219	0.909	0.544	1.246	12.514	0.817	-0.544	0.909	0.580	1.279	13.464	0.808	-0.580
17220	0.974	0.471	0.617	11.526	0.922	-0.471	0.975	0.329	0.489	8.055	0.951	-0.329
17221	0.963	0.213	0.479	6.368	0.918	0.213	0.965	0.398	0.644	11.889	0.853	0.398
17383	0.971	0.454	0.550	12.003	0.910	-0.454	0.974	0.023	0.381	0.600	0.957	-0.023
17384	0.966	0.764	0.845	18.663	0.807	-0.764	0.967	0.366	0.522	8.954	0.926	-0.366
17439	0.902	0.402	0.709	10.596	0.855	-0.402	0.875	0.009	0.708	0.232	0.856	0.009
17440	0.969	0.422	0.581	10.736	0.922	-0.422	0.977	0.204	0.377	5.179	0.967	-0.204
17441	0.971	0.230	0.396	6.226	0.954	-0.230	0.976	0.020	0.339	0.547	0.966	-0.020
17442	0.962	0.629	0.814	15.314	0.865	-0.629	0.965	0.325	0.534	7.924	0.942	-0.325
17443	0.678	0.483	1.110	17.419	0.388	0.483	0.678	1.071	1.592	38.642	-0.259	1.071
17444	0.936	0.221	0.573	5.856	0.922	-0.221	0.929	0.109	0.558	2.887	0.926	0.109
17742	0.978	0.100	0.410	2.633	0.968	-0.100	0.977	0.231	0.497	6.090	0.953	-0.231
17749	0.976	0.086	0.445	2.348	0.965	0.086	0.984	0.129	0.491	3.514	0.957	-0.129
17782	0.964	1.091	1.223	23.960	0.715	-1.091	0.956	0.889	1.039	19.523	0.794	-0.889
17787	0.982	0.256	0.401	6.618	0.965	-0.256	0.979	0.209	0.379	5.401	0.968	-0.209
17789	0.959	0.015	0.420	0.403	0.957	0.015	0.973	0.152	0.365	4.072	0.968	-0.152
17790	0.958	0.108	0.455	2.954	0.956	0.108	0.963	0.016	0.420	0.427	0.962	0.016
17822	0.983	0.534	0.607	15.964	0.917	0.534	0.982	0.307	0.421	9.192	0.960	0.307
17854	0.974	0.488	0.659	14.740	0.864	0.488	0.967	0.299	0.487	9.007	0.926	0.299
18028	0.977	0.595	0.687	14.540	0.890	-0.595	0.980	0.338	0.448	8.250	0.953	-0.338
18030	0.978	0.003	0.496	0.076	0.961	-0.003	0.984	0.062	0.487	1.584	0.962	-0.062
18031	0.925	0.396	0.808	9.545	0.887	-0.396	0.929	0.479	0.837	11.545	0.878	-0.479
18032	0.975	0.534	0.619	13.269	0.902	-0.534	0.983	0.325	0.418	8.081	0.955	-0.325
18034	0.982	0.197	0.441	5.430	0.966	0.197	0.987	0.067	0.424	1.837	0.968	0.067
18035	0.984	0.471	0.542	14.105	0.932	0.471	0.990	0.311	0.379	9.292	0.967	0.311
18038	0.978	0.092	0.434	2.469	0.964	-0.092	0.978	0.029	0.413	0.783	0.968	-0.029
18049	0.781	0.149	1.192	3.998	0.777	0.149	0.784	0.042	1.178	1.132	0.782	0.042
18050	0.968	0.766	0.872	17.139	0.845	-0.766	0.964	0.660	0.789	14.780	0.873	-0.660
18441	0.988	0.742	0.805	23.475	0.832	0.742	0.984	0.545	0.607	17.251	0.904	0.545
18443	0.971	0.581	0.859	13.711	0.886	-0.581	0.974	0.579	0.849	13.647	0.888	-0.579
18444	0.979	0.017	0.303	0.469	0.973	0.017	0.982	0.109	0.341	3.060	0.966	0.109
18445	0.873	0.114	0.776	3.527	0.868	0.114	0.867	0.073	0.797	2.261	0.861	0.073
18446	0.980	0.271	0.510	6.801	0.954	-0.271	0.977	0.212	0.486	5.330	0.958	-0.212
18447	0.983	0.496	0.570	14.966	0.927	0.496	0.983	0.318	0.426	9.588	0.959	0.318
18448	0.978	0.627	0.799	15.020	0.886	-0.627	0.981	0.558	0.728	13.356	0.905	-0.558
18450	0.978	0.420	0.547	10.648	0.935	-0.420	0.982	0.314	0.439	7.957	0.958	-0.314
18901	0.978	0.098	0.439	2.731	0.961	-0.098	0.978	0.124	0.473	3.433	0.955	-0.124
Average	0.952	0.371	0.648	9.726	0.893	-0.153	0.953	0.301	0.600	8.050	0.894	-0.095

Table 7. Station-based performance metrics of the Mahringer equation using Am and Bm (LS) calibration.

	Mahringer					
Station	R2	MAE	RMSE	PE	NSE	MBE
9020	0.994	0.029	0.161	0.741	0.994	0.029
17180	0.994	0.062	0.169	1.889	0.992	-0.062
17218	0.996	0.046	0.153	1.112	0.996	0.046
17219	0.999	0.042	0.128	0.964	0.998	-0.042
17220	0.998	0.012	0.103	0.298	0.998	-0.012
17221	0.992	0.086	0.176	2.581	0.989	-0.086
17383	0.997	0.004	0.108	0.097	0.997	-0.004
17384	0.996	0.011	0.126	0.274	0.996	0.011
17439	0.995	0.062	0.158	1.643	0.993	0.062
17440	0.998	0.003	0.104	0.065	0.998	-0.003
17441	0.997	0.012	0.101	0.322	0.997	0.012
17442	0.998	0.054	0.105	1.322	0.998	-0.054
17443	0.969	0.168	0.333	6.053	0.945	0.168
17444	0.997	0.009	0.118	0.226	0.997	-0.009
17742	0.998	0.063	0.114	1.662	0.998	0.063
17749	0.998	0.076	0.145	2.078	0.996	0.076
17782	0.997	0.021	0.129	0.458	0.997	-0.021
17787	0.999	0.027	0.066	0.692	0.999	0.027
17789	0.983	0.096	0.299	2.573	0.978	0.096
17790	0.995	0.018	0.149	0.484	0.995	0.018
17822	0.998	0.017	0.098	0.514	0.998	0.017
17854	0.994	0.061	0.159	1.855	0.992	0.061
18028	0.998	0.024	0.100	0.598	0.998	-0.024
18030	0.999	0.068	0.100	1.746	0.998	-0.068
18031	0.982	0.054	0.330	1.289	0.981	0.054
18032	0.999	0.045	0.089	1.114	0.998	0.045
18034	0.999	0.029	0.101	0.788	0.998	0.029
18035	0.999	0.004	0.078	0.110	0.999	0.004
18038	0.999	0.025	0.079	0.663	0.999	-0.025
18049	0.953	0.001	0.642	0.015	0.935	-0.001
18050	0.999	0.072	0.108	1.603	0.998	-0.072
18441	0.997	0.017	0.112	0.524	0.997	-0.017
18443	0.999	0.001	0.079	0.022	0.999	-0.001
18444	0.999	0.019	0.070	0.523	0.999	-0.019
18445	0.989	0.269	0.358	8.316	0.972	0.269
18446	0.998	0.053	0.112	1.333	0.998	-0.053
18447	0.996	0.074	0.190	2.245	0.992	0.074
18448	0.999	0.037	0.098	0.893	0.998	0.037
18450	0.999	0.071	0.108	1.796	0.997	0.071
18901	0.998	0.174	0.213	4.843	0.991	0.174
Average	0.995	0.050	0.154	1.408	0.992	0.022

Station-based performance metrics calculated using A_mB_m (LS) coefficients are presented in Tables 6 and 7 for the Hargreaves–Samani and Priestley–Taylor equations, and the Mahringer equation, respectively. The results indicate that model performance varies across stations, suggesting the influence of site-specific conditions.

In addition to accuracy-based metrics (R^2, MAE, RMSE, and PE), Tables 6 and 7 also include efficiency and bias indicators (NSE and MBE), providing a more comprehensive evaluation of model performance. The NSE values generally indicate high model efficiency across most stations, while MBE values are close to zero, suggesting limited systematic bias after calibration. Error metrics for all models are given in Supplementary Table S2.

The results also confirm the superior performance of monthly calibration and A–B formulations, consistent with the trends observed in Table 5. The effect of calibration is particularly evident for the Mahringer equation, which shows very strong agreement with PM-FAO56 values across stations, supported by both graphical analysis (Supplementary Figures S3 and S4) and statistical performance (Tables 5–7).

Overall, these findings confirm that both LS and GB approaches yield comparable calibration results, while the use of monthly coefficients significantly enhances model performance under varying local conditions, which may reflect climatic variability.

Following the evaluation of calibration strategies and coefficient estimation methods, the overall performance of the calibrated empirical ET_0 equations was assessed relative to the PM-FAO56 reference method.

After calibration using monthly A_mB_m coefficients, all empirical equations exhibited strong agreement with the PM-FAO56 reference method. The calibrated performance metrics were R^2 = 0.948, MAE = 0.49, RMSE = 0.77, PE = 12.82, NSE=0.847 and MBE=-0.36 for the Hargreaves and Samani equation; R^2 = 0.95, MAE = 0.31, RMSE = 0.61, PE = 8.15, NSE=0.889 and MBE=-0.10 for the Priestley and Taylor equation; and R^2 = 0.994, MAE = 0.05, RMSE = 0.16, PE = 1.49, NSE=0.992 and MBE=-0.01 for the Mahringer equation. In addition, NSE values approached one and MBE values were close to zero, indicating high model efficiency and minimal systematic bias after calibration.

Station-based performance metrics (Tables 6 and 7) further demonstrate that the improvements are consistent across most locations, although some variability exists due to local climatic differences. Among the tested models, the Mahringer equation yielded the highest accuracy and the most stable performance across stations.

Accordingly, the calibrated empirical equations using Equation (7) and monthly coefficients are expressed as:

$$ET_0 = 0.408\left(A'_{m,HAS} + B'_{m,HAS}R_a(T_a + 17.8)\sqrt{T_{max} - T_{min}}\right) \quad (18)$$

$$ET_0 = A_{m,PRT} + B_{m,PRT}\,\alpha\,\frac{\Delta}{\Delta+\gamma}\frac{R_n - G}{\lambda} \quad (19)$$

$$ET_0 = A_{m,MAH} + B'_{m,MAH}U^{0.5}(e_s - e_a) \quad (20)$$

where $A'_{m,HAS}$, $B'_{m,HAS}$', and $B'_{m,MAH}$ are equal to $A_{m,HAS}/0.408$, $0.0023B_{m,HAS}$ and $2.86B_{m,MAH}$ respectively. When K_m coefficients are employed, calibrated ET_0 values are obtained by multiplying the original empirical equations by the corresponding K_m coefficient, yielding:

$$ET_0 = A_{m,MAH} + B'_{m,MAH}U^{0.5}(e_s - e_a) \quad (21)$$

$$ET_0 = K_{m,PRT}\,\alpha\,\frac{\Delta}{\Delta+\gamma}\frac{R_n - G}{\lambda} \quad (22)$$

$$ET_0 = K'_{m,MAH}U^{0.5}(e_s - e_a) \quad (23)$$

where $K'_{m,HAS} = 0.023K_{m,HAS}$ and $K'_{m,MAH} = 2.86K_{m,MAH}$. The monthly A, B, and K coefficients calculated using the LS method are given in Table 8, while the constant A, B, and K coefficients are given in Table 9.

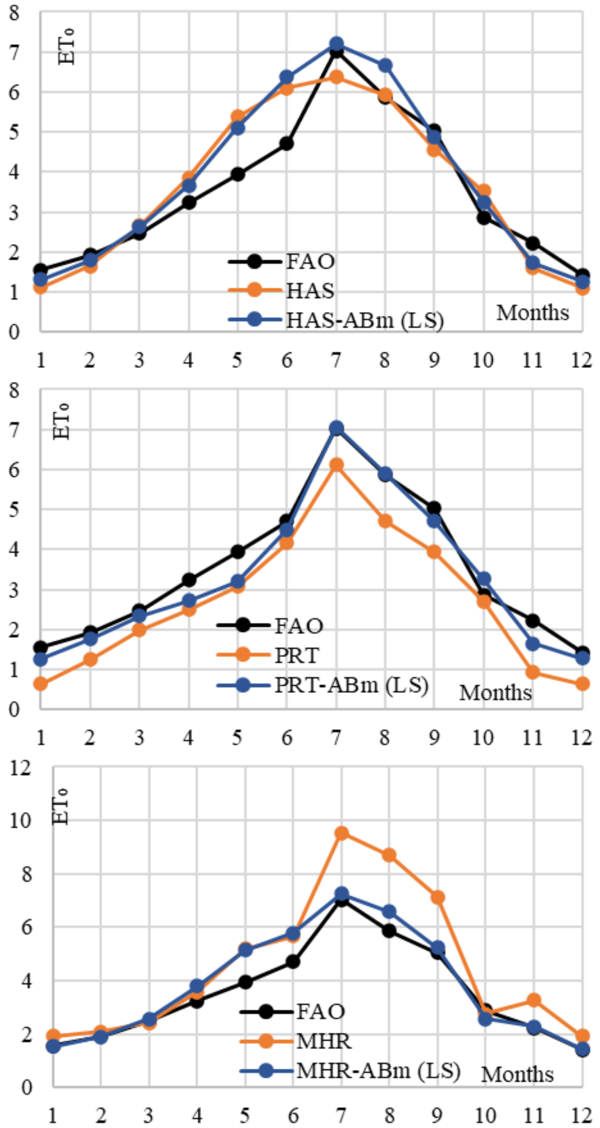


Fig. 7. PM-FAO56 and Evapotranspiration values calculated for station 17789 in 2020 using original and calibrated empirical equations.

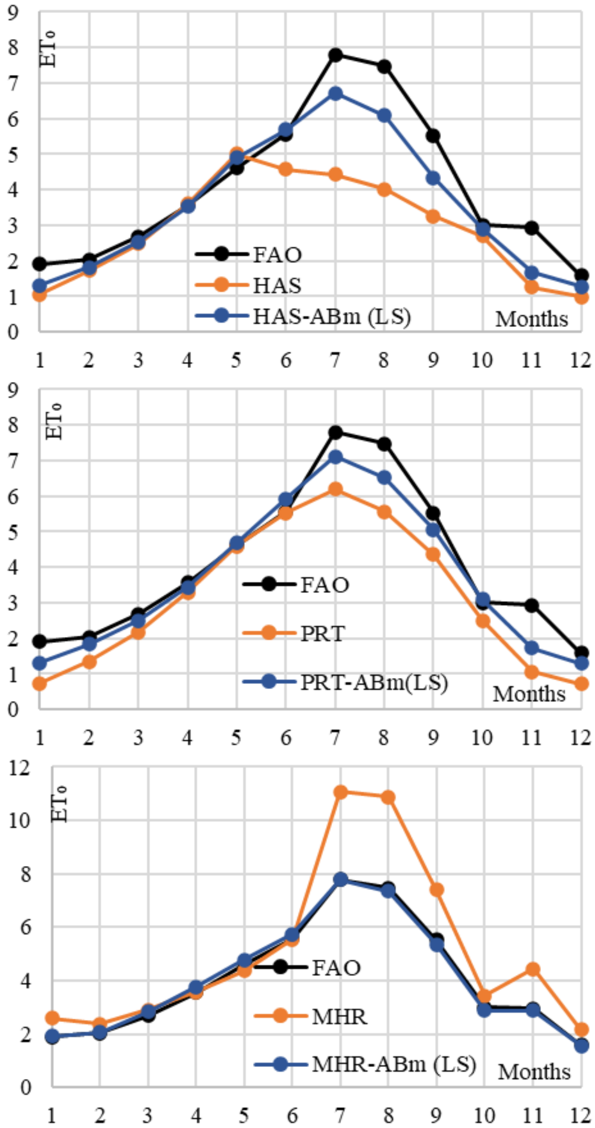


Fig. 8. PM-FAO56 and Evapotranspiration values calculated for station 17440 in 2020 using original and calibrated empirical equations.

Table 8. Adjusted values of monthly calibration coefficients using Least squares methods in Izmir province.

		January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
HAS	**Km**	1.209	1.139	1.038	0.979	0.992	1.073	1.187	1.212	1.152	1.107	1.116	1.239
	Am	1.192	1.255	1.253	1.508	2.129	3.634	5.592	4.890	3.042	1.779	1.504	1.388
	Bm	0.105	0.321	0.516	0.559	0.554	0.449	0.253	0.298	0.399	0.414	0.136	-0.111
PRT	**Km**	1.853	1.402	1.148	1.040	1.015	1.069	1.148	1.172	1.201	1.310	1.667	2.146
	Am	0.918	0.738	0.546	0.471	0.252	0.173	3.667	2.529	1.357	1.176	1.050	1.167
	Bm	0.551	0.810	0.897	0.901	0.962	1.039	0.555	0.715	0.851	0.769	0.645	0.180
MAH	**Km**	0.856	0.972	1.103	1.154	1.084	0.903	0.783	0.769	0.817	0.845	0.797	0.777
	Am	0.445	0.779	1.295	2.023	2.849	3.639	4.009	3.533	2.353	1.288	0.621	0.387
	Bm	0.564	0.539	0.530	0.491	0.443	0.377	0.341	0.350	0.404	0.462	0.508	0.541

Table 9. Adjusted values of fixed calibration coefficients using Least squares methods in Izmir Province

HAS			PRT			MAH		
K	A	B	K	A	B	K	A	B
0,026	0,843	0,023	1,179	0,565	0,999	2,508	1,228	1,676

Figures 7 and 8 show the ET_0 estimates for 2020 obtained using empirical equations for stations 17789 and 17440. The monthly variation of ET_0 values for 2020 at all stations is shown in Supplementary Figure S3, and the monthly variation of average ET_0 values during the observation period is shown in Supplementary Figure S4. Additionally, scatter plots of average ET_0 values for all stations during the observation period are shown in Supplementary Figure S5, and error box plots for all stations are shown in Supplementary Figure S6.

Overall, calibration substantially improved the performance of all empirical equations. Compared with the original formulations, the Priestley and Taylor equation showed improvement in 138 out of 160 evaluated error cases, the Hargreaves and Samani equation in 148 cases, and the Mahringer equation at all stations.

4 DISCUSSION

4.1 Comparison of calibration methods

Calibration using Equation (7) with monthly A_mB_m coefficients consistently outperformed the multiplicative calibration approach based on Equation (6). By adjusting both the intercept and slope, the A_mB_m formulation more effectively captured temporal variability in ET_0 at a monthly resolution, resulting in improved agreement with PM-FAO56 across all empirical models. The most pronounced improvement was observed for the Mahringer equation, which achieved very strong agreement after calibration.

The nearly identical performance obtained with this gradient-based optimization approach and the traditional least squares method confirms that the calibration task is inherently linear. Therefore, the gradient-based method does not provide a meaningful accuracy advantage over least squares for this specific problem, but offers an additional option for parameter estimation.

In addition to improving statistical agreement, the A_mB_m-based monthly calibration enhanced overall model reliability across multiple performance criteria, including NSE and MBE. The increase in NSE values and the convergence of MBE values toward zero indicate a substantial reduction in systematic bias and improved model efficiency. This confirms that the linear correction approach is not only statistically superior but also more robust in representing the underlying physical variability of ET_0.

Consistent with this, the observed superiority of monthly calibration over fixed annual coefficients can be attributed to the strong intra-annual variability of key meteorological drivers such as solar radiation, temperature, and vapor pressure deficit. Fixed coefficients fail to capture this temporal variability, leading to reduced accuracy. In contrast, monthly calibration implicitly accounts for seasonal dynamics through time-varying parameters, resulting in systematic improvements in error metrics and model efficiency. The consistency of this improvement across multiple stations indicates that the advantage of monthly calibration is robust and largely independent of site-specific conditions.

Accordingly, the primary contribution of this study lies in the regional calibration results and the practical guidance provided for the İzmir region, rather than in methodological innovation.

4.2 Influence of Local Climatic Conditions

The superior performance of the calibrated Mahringer equation under İzmir's humid Mediterranean conditions (relative humidity > 65%) is consistent with previous findings for coastal and humid climates. Among the original (uncalibrated) equations, the radiation-based Priestley and Taylor method provided the best performance (R^2 = 0.932, MAE = 0.68, RMSE = 0.92, PE = 7.32, NSE=0.796, MBE=-0.65), followed by the Hargreaves and Samani and Mahringer equations. These results are consistent with previous findings reported in humid and subtropical climates (Vishwakarma et al., 2022). The calibration process substantially enhanced the accuracy of the mass transfer–based Mahringer model, making it the most reliable option for the study region.

These results highlight the importance of adapting empirical ET_0 equations to local climatic conditions, particularly in regions where humidity and radiation regimes exhibit strong intra-annual variability. Similar conclusions have been reported in Mediterranean and European studies, where locally calibrated empirical equations generally outperform globally derived formulations due to strong seasonal variability in radiation, humidity, and temperature regimes (Koç, 2022; Azzam et al., 2023). These studies likewise emphasized that locally optimized coefficients substantially improve ET_0 estimation reliability under region-specific climatic conditions.

The effects of local climatic conditions on model performance are also reflected in the graphical analyses presented in Supplementary Figure S5. The results indicate that, after monthly calibration, the Mahringer equation shows very strong agreement with the reference method, while the Hargreaves and Samani and Priestley and Taylor equations also exhibit improved agreement, as reflected by the concentration of data points around the 1:1 line. In addition, heteroscedasticity observed before calibration was substantially reduced after calibration. Supplementary Figure S6 presents the distribution of estimation errors across stations. The boxplots indicate that, before calibration, estimation errors were generally higher during periods of elevated evapotranspiration demand. After calibration, both error dispersion and systematic bias decreased substantially for all empirical equations, although some inter-station variability remained under local climatic conditions.

The strong performance of the mass transfer–based Mahringer equation after calibration is also consistent with previous studies conducted under humid and semi-humid climatic conditions. Similar findings have been reported by Valipour (2015), Ndiaye et al. (2020), Sharafi and Mohammadi Ghaleni (2021), and Hadria et al. (2021). This agreement with the literature further supports the robustness and physical relevance of the calibration results obtained in this study.

Overall, calibration led to substantial improvements in model performance across all empirical equations. The number of cases showing improved accuracy increased markedly after calibration, particularly for the Mahringer equation, which achieved very high agreement with the reference method at most stations. These improvements were consistently reflected in both graphical analyses and statistical performance metrics, reinforcing the effectiveness of the applied calibration strategy.

4.3 Impact of Missing Data Completion (ADS) and Uncertainty

A key methodological aspect of this study is the reconstruction of missing actual duration of sunshine (ADS) data using a regression-based approach. To evaluate its impact, calibration was performed under two scenarios: (i) using only stations with complete ADS observations and (ii) using the full dataset including reconstructed ADS values. The comparison showed negligible differences across all empirical models and performance metrics, with no effect on model ranking or the overall conclusions of the study.

These results indicate that inclusion of reconstructed ADS data does not introduce significant systematic bias into the calibration process. Although slight differences were observed between stations with measured and reconstructed ADS data, these remained marginal. In contrast, excluding stations with missing ADS data would substantially reduce the usable meteorological dataset and weaken spatial representativeness.

Supporting evidence from multi-station validation (Table 2), residual diagnostics (Supplementary Figure S1), and comparative calibration analyses (Figures 2–5, Supplementary Table S1, and Supplementary Figure S2) consistently indicates that the uncertainty introduced by ADS infilling is limited and non-systematic. Differences in calibrated coefficients and error metrics remained negligible even when stations with high proportions of missing data were excluded. Comparative calibration scenarios indicate that the uncertainty introduced by ADS infilling is limited relative to the improvements achieved through calibration.

Overall, the results demonstrate that ADS infilling provides a practical approach for improving dataset completeness and spatial representativeness under data-scarce conditions without substantially affecting calibration reliability. Nevertheless, regression-based infilling introduces some uncertainty, particularly in radiation-sensitive ET_0 components, and more comprehensive uncertainty propagation approaches may be considered in future studies.

4.4 Practical Implications

For Mediterranean and other humid climates where meteorological data availability may be limited, the calibrated Mahringer equation provides a practical and reliable alternative for ET_0 estimation. The use of monthly calibration coefficients enables a more detailed representation of temporal variability throughout the year compared to fixed annual coefficients, offering clear advantages for irrigation planning and water resource management.

The results also demonstrate that relatively simple empirical equations, when properly calibrated, can achieve performance levels comparable to more complex approaches under regional climatic conditions. Similar observations have been reported in previous ET_0 studies, where locally calibrated empirical models remained competitive despite the strong predictive capability of ML/DL approaches, particularly in operational and data-scarce environments where interpretability and robustness are important considerations (Chen et al., 2020; Bellido-Jiménez et al., 2022; Di Nunno and Granata, 2023).

4.5 Limitations and Future Work

Despite the strong performance of the calibrated models, several limitations should be noted. Although the effects of missing ADS data reconstruction were evaluated through residual diagnostics, sensitivity analyses, and comparative calibration scenarios, a full probabilistic uncertainty propagation framework was not implemented. In addition, the study focuses on a specific Mediterranean climatic region, and the transferability of the derived coefficients to other climatic conditions remains to be evaluated.

Future work should aim to:

(i) apply more comprehensive uncertainty propagation frameworks from input variables to ET_0 estimates,

(ii) evaluate the spatial transferability of calibrated coefficients across different climatic zones, and

(iii) explore hybrid approaches combining empirical calibration with machine learning models for improved generalization.

5 CONCLUSION

Accurate estimation of reference evapotranspiration (ET_0) is essential for efficient agricultural water management, particularly in water-limited Mediterranean regions such as İzmir, Türkiye. In this study, three widely used empirical ET_0 equations (Hargreaves–Samani, Priestley–Taylor, and Mahringer) were evaluated and regionally calibrated against the FAO56 Penman–Monteith method. The analysis focused on improving model performance under data-limited conditions and assessing the effectiveness of monthly versus fixed calibration coefficients using least squares (LS) and a gradient-based optimization approach.

The results demonstrate that regional calibration is critical for improving the reliability of empirical ET_0 equations. Among the tested models, the Mahringer equation showed the most substantial improvement after calibration and achieved the highest agreement with PM-FAO56, indicating its suitability for Mediterranean climatic conditions. While the Priestley–Taylor equation performed reasonably well in its original form, all models benefited from calibration.

Monthly calibration coefficients consistently outperformed fixed coefficients by better capturing intra-annual variability, leading to systematic improvements in accuracy metrics across all stations. In contrast, no meaningful differences were observed between LS and gradient-based calibration methods, confirming that the calibration problem is predominantly linear.

The inclusion of stations with missing sunshine duration (ADS) data completed using regression-based methods enabled the use of a larger and more representative dataset. The comparison between calibrations performed with and without infilled data showed only minor differences in performance metrics, generally at the third decimal level, indicating that the infilling procedure does not significantly affect the overall conclusions. This suggests that incorporating infilled data is a practical approach for enhancing calibration robustness when data availability is limited. Nevertheless, uncertainty associated with missing data completion remains a limitation and should be further quantified in future studies.

Overall, this study provides a region-specific evaluation and calibration framework for empirical ET_0 estimation in Mediterranean climates. The findings highlight that relatively simple empirical equations, when properly calibrated using locally derived monthly coefficients, can achieve high levels of accuracy comparable to the reference method. This offers a practical and transparent alternative for irrigation planning and water resource management in data-scarce regions. The results are expected to contribute to more accurate estimation of agricultural water requirements and more efficient irrigation water use in İzmir when the calibrated equations are applied.

Future research should focus on quantifying uncertainty propagation from input variables, evaluating the spatial transferability of calibrated coefficients, and exploring hybrid or nonlinear calibration approaches to further improve model generalization.

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Supplementary Documents S1: Workflow Overview

The overall workflow consists of three main steps: (i) data preprocessing and calculation of ET_0 values, (ii) calibration of empirical ET_0 equations, and (iii) performance evaluation. The procedures were implemented in MATLAB using modular scripts.

1. Data Preprocessing

For each station:

Load daily meteorological data (air temperature (min,max, average), relative humidity (min,max,average), wind speed (2m), and sunshine duration)
Identify missing values:
If only sunshine duration (ADS) data are missing and other required variables are available:
Estimate missing ADS values using regression-based relationships derived from stations with complete data
Compute reference ET_0 using the PM-FAO56 method
Compute empirical ET_0 values (Hargreaves–Samani, Priestley–Taylor, Mahringer)

2. Calibration Procedure

For each month (or full dataset for fixed coefficients):
For each station:
Define x = empirical ET_0
Define y = PM-FAO56 ET_0

(a) Least squares (LS) approach
Case 1: Single coefficient (K)
Estimate K using least squares:
K = sum(x*y) / sum(x^2)
Case 2: Linear form (A + Bx)
Estimate A and B using linear regression

(b) Gradient-based approach
Initialize parameters (K or A, B)
For iteration = 1 to N:
Compute predicted ET_0:
y_pred = K*x or y_pred = A + B*x
Compute error:
e = y_pred - y
Update parameters using gradient descent:
$K = K - \alpha \, \partial J/\partial K$
$A = A - \alpha \, \partial J/\partial A$
$B = B - \alpha \, \partial J/\partial B$

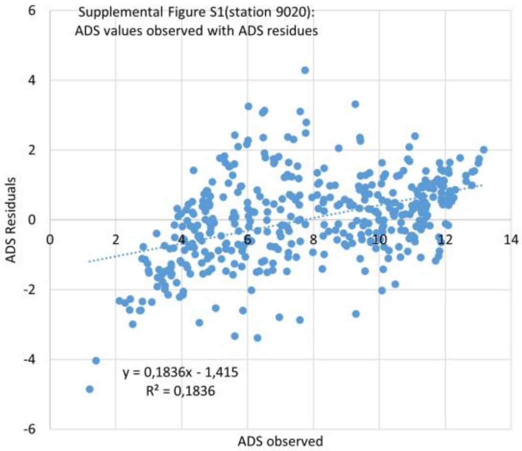
3. Performance Evaluation

For each station and model:
Compute performance metrics: R^2, MAE, RMSE, PE, NSE, MBE
Compare empirical models against PM-FAO56 reference

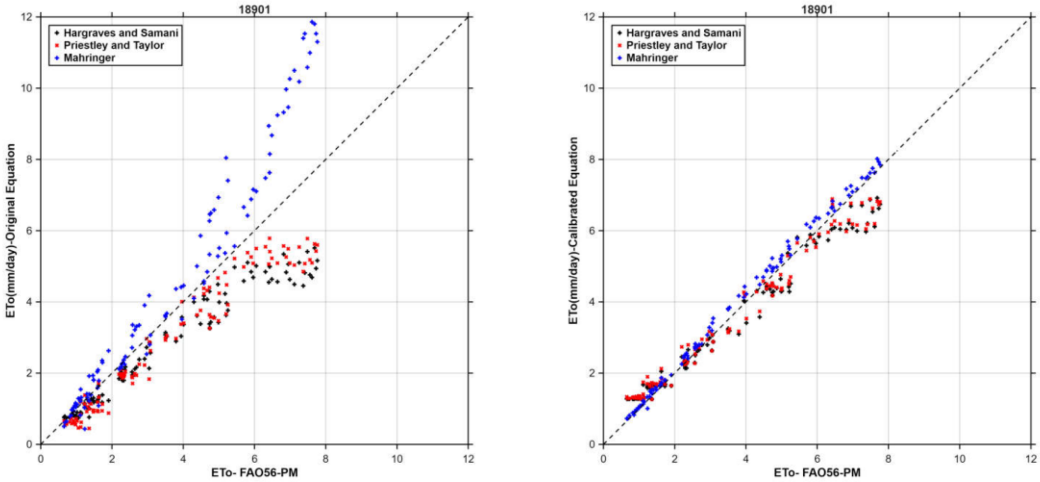
Calibration and performance evaluation were implemented as separate computational steps to ensure independent verification of model parameters and error metrics.

Supplementary materials: Below are only example graphs for one station. The complete Supplementary Materials containing graphs for all stations can be accessed via the following link: https://drive.google.com/drive/folders/1AOezG0_LedUtG4eZ_0YU-aIEbQILk-4tv?usp=sharing

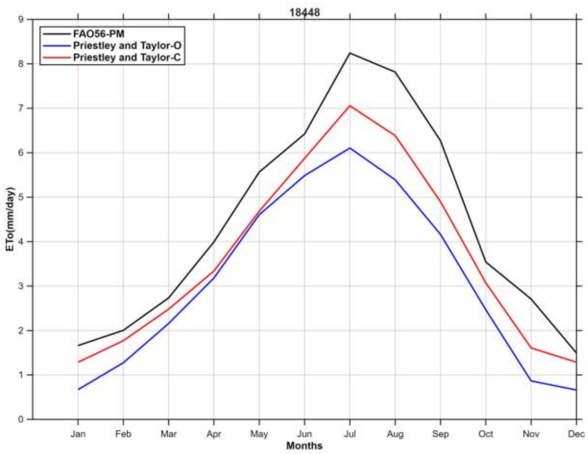
Supplementary figure S1. Residual diagnostic plot of the linear regression model for infilling actual duration of sunshine (ADS) residuals versus observed ADS values.



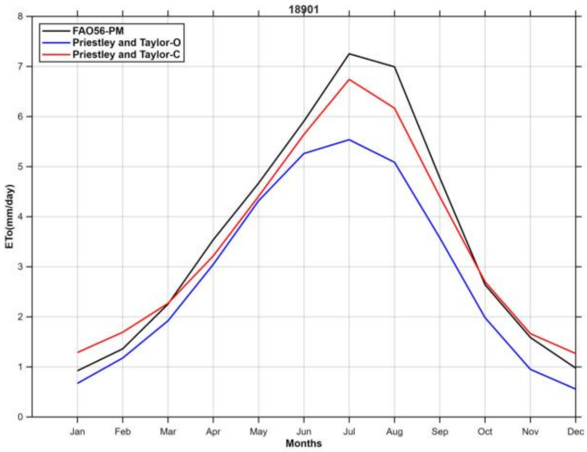
Supplementary figure S2. Scatter plots of the ET_0 values calculated with calibration using only stations with measured ADS data.



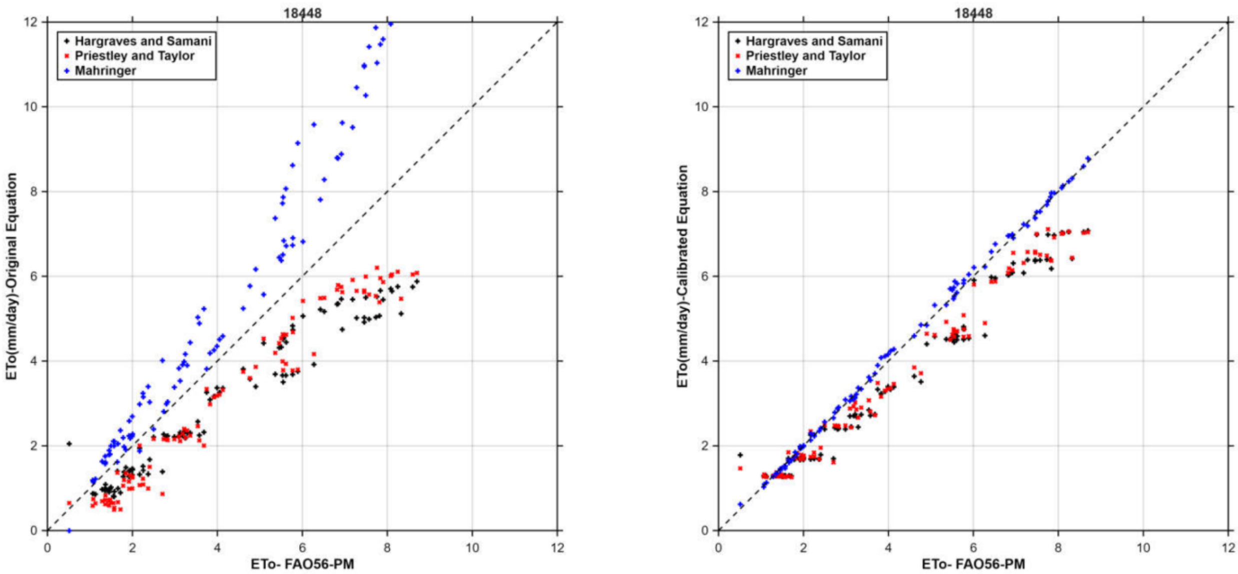
Supplementary figure S3. Average monthly ETo (mm/day) values calculated with original and calibrated equations in 2020 for all stations.



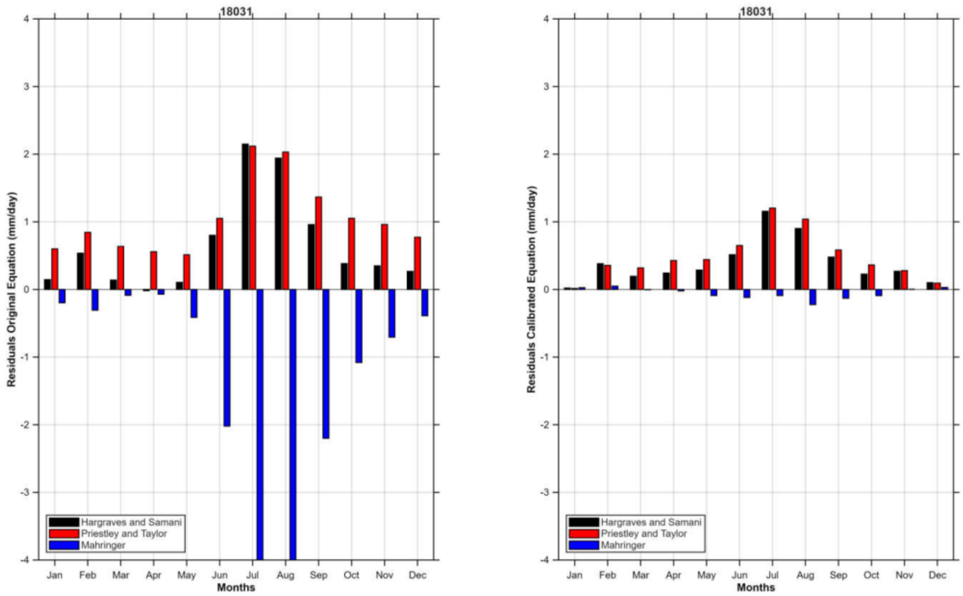
Supplementary figure S4. Average monthly ETo (mm/day) values calculated with original and calibrated equations during the observation period for all stations.



Supplementary figure S5. Scatter plots for average monthly ETo (mm/day) for all stations throughout the observation years.



Supplementary figure S6. Error box plots for average monthly ETo (mm/day) values calculated with original and calibrated equations during the observation period for all stations.



Supplementary Table S1. Error rates of the original equations and calibrated equations obtained using only stations with complete ADS data.

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.33	0.69	8.39	0.88	-0.33	0.92	0.83	1.00	21.13	0.75	-0.83	0.88	0.79	1.44	20.13	0.48	0.79
17180	0.96	0.31	0.54	9.55	0.91	-0.31	0.96	0.10	0.48	2.91	0.93	-0.10	0.86	0.24	0.75	7.18	0.83	-0.24
17218	0.93	0.68	0.99	16.42	0.83	-0.68	0.94	1.12	1.31	26.75	0.70	-1.12	0.95	1.33	2.05	31.84	0.25	1.33
17219	0.85	0.80	1.58	18.42	0.71	-0.80	0.86	1.13	1.71	26.18	0.66	-1.13	0.95	1.47	2.85	34.10	0.05	1.47
17220	0.96	0.96	1.16	23.49	0.72	-0.96	0.96	0.88	0.99	21.44	0.80	-0.88	0.94	1.02	1.56	25.05	0.50	1.02
17221	0.93	0.36	0.59	10.77	0.88	-0.36	0.96	0.15	0.54	4.39	0.90	-0.15	0.79	0.27	0.81	8.07	0.77	-0.27
17383	0.94	1.38	1.59	36.55	0.25	-1.38	0.96	0.56	0.71	14.81	0.85	-0.56	0.93	0.54	0.86	14.39	0.78	0.54
17384	0.89	1.71	1.94	41.65	-0.01	-1.71	0.94	0.92	1.04	22.40	0.71	-0.92	0.94	1.02	1.37	24.96	0.49	1.02
17439	0.83	1.33	1.64	34.99	0.23	-1.33	0.84	0.54	0.95	14.13	0.74	-0.54	0.90	0.65	1.19	17.12	0.59	0.65
17440	0.83	1.08	1.47	27.37	0.50	-1.08	0.95	0.75	0.89	18.95	0.82	-0.75	0.94	0.84	1.34	21.46	0.59	0.84
17441	0.88	0.88	1.15	23.68	0.61	-0.88	0.96	0.57	0.69	15.35	0.86	-0.57	0.93	0.53	0.84	14.21	0.79	0.53
17442	0.88	1.29	1.65	31.41	0.45	-1.29	0.94	0.86	1.02	20.83	0.79	-0.86	0.94	0.98	1.52	23.82	0.53	0.98
17443	0.47	0.51	1.16	18.49	0.33	-0.51	0.65	0.57	1.31	20.42	0.14	0.57	0.61	0.46	1.24	16.42	0.24	-0.46
17444	0.84	1.00	1.41	26.42	0.53	-1.00	0.91	0.43	0.76	11.34	0.86	-0.43	0.92	0.49	1.11	12.91	0.71	0.49
17742	0.95	0.46	0.77	12.19	0.89	-0.46	0.95	0.82	1.01	21.65	0.81	-0.82	0.95	0.89	1.55	23.48	0.55	0.89
17749	0.94	0.12	0.64	3.15	0.93	-0.12	0.96	0.71	0.94	19.25	0.84	-0.71	0.95	0.85	1.66	23.21	0.51	0.85
17782	0.91	1.76	2.03	38.71	0.22	-1.76	0.91	1.45	1.62	31.79	0.50	-1.45	0.95	1.65	2.20	36.13	0.07	1.65
17787	0.95	0.72	0.95	18.72	0.80	-0.72	0.96	0.77	0.89	19.97	0.83	-0.77	0.94	0.84	1.37	21.75	0.59	0.84
17789	0.94	0.27	0.58	7.09	0.92	-0.27	0.95	0.73	0.85	19.46	0.83	-0.73	0.92	0.81	1.37	21.55	0.54	0.81
17790	0.92	0.14	0.64	3.95	0.91	-0.14	0.94	0.55	0.77	15.08	0.88	-0.55	0.91	0.57	1.35	15.44	0.61	0.57
17822	0.98	0.52	0.61	15.40	0.92	0.52	0.98	0.25	0.43	7.49	0.96	-0.25	0.93	0.17	0.93	5.08	0.81	0.17
17854	0.97	0.34	0.49	10.30	0.92	0.34	0.97	0.28	0.45	8.33	0.94	-0.28	0.90	0.11	0.68	3.19	0.86	0.11
18028	0.92	1.26	1.48	30.68	0.49	-1.26	0.96	0.87	0.96	21.15	0.79	-0.87	0.95	0.96	1.31	23.38	0.60	0.96
18030	0.94	0.03	0.71	0.88	0.92	-0.03	0.96	0.57	0.83	14.69	0.89	-0.57	0.95	0.79	1.74	20.33	0.52	0.79
18031	0.86	0.64	1.16	15.35	0.77	-0.64	0.89	1.04	1.32	24.93	0.70	-1.04	0.92	1.34	2.20	32.30	0.16	1.34
18032	0.97	1.20	1.29	29.85	0.58	-1.20	0.97	0.87	0.93	21.67	0.78	-0.87	0.95	1.00	1.31	24.92	0.56	1.00
18034	0.95	0.08	0.61	2.29	0.94	0.08	0.96	0.47	0.74	13.01	0.90	-0.47	0.94	0.67	1.66	18.47	0.51	0.67
18035	0.95	0.34	0.59	10.01	0.92	0.34	0.97	0.24	0.43	7.15	0.96	-0.24	0.93	0.13	0.94	4.01	0.80	0.13
18038	0.93	0.51	0.91	13.70	0.84	-0.51	0.95	0.57	0.81	15.33	0.88	-0.57	0.94	0.62	1.38	16.52	0.64	0.62
18049	0.76	0.18	1.26	4.88	0.75	0.18	0.77	0.47	1.31	12.75	0.73	-0.47	0.83	0.68	2.58	18.22	-0.05	0.68
18050	0.93	1.06	1.25	23.76	0.68	-1.06	0.93	1.18	1.32	26.32	0.65	-1.18	0.94	1.37	1.95	30.74	0.22	1.37
18441	0.99	0.78	0.85	24.57	0.81	0.78	0.98	0.00	0.29	0.05	0.98	0.00	0.90	0.16	0.80	5.08	0.83	-0.16
18443	0.93	0.93	1.32	21.96	0.73	-0.93	0.95	1.13	1.36	26.73	0.71	-1.13	0.96	1.43	2.26	33.70	0.21	1.43
18444	0.96	0.44	0.61	12.25	0.89	-0.44	0.98	0.44	0.53	12.34	0.92	-0.44	0.95	0.30	0.58	8.31	0.90	0.30
18445	0.86	0.74	1.21	22.84	0.68	-0.74	0.83	0.56	1.07	17.23	0.75	-0.56	0.94	0.64	1.40	19.85	0.57	0.64
18446	0.96	0.51	0.80	12.80	0.89	-0.51	0.97	0.74	0.90	18.61	0.86	-0.74	0.95	0.92	1.59	22.99	0.55	0.92
18447	0.97	0.42	0.55	12.57	0.93	0.42	0.96	0.24	0.48	7.15	0.95	-0.24	0.90	0.35	1.32	10.44	0.61	0.35
18448	0.95	1.15	1.40	27.47	0.65	-1.15	0.96	1.12	1.26	26.91	0.72	-1.12	0.97	1.36	1.95	32.69	0.32	1.36
18450	0.96	0.98	1.15	24.72	0.71	-0.98	0.97	0.88	0.97	22.20	0.80	-0.88	0.95	1.09	1.56	27.55	0.47	1.09
18901	0.95	0.81	1.13	22.59	0.74	-0.81	0.95	0.74	0.97	20.48	0.81	-0.74	0.95	0.86	1.49	23.93	0.55	0.86

Calibration with monthly K coefficients (LR)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.94	0.16	0.65	4.15	0.90	0.16	0.94	0.27	0.57	6.93	0.92	-0.27	0.91	0.24	0.77	6.03	0.85	0.24
17180	0.96	0.10	0.37	3.08	0.96	0.10	0.97	0.48	0.67	14.74	0.87	0.48	0.89	0.60	0.88	18.13	0.77	-0.60
17218	0.97	0.21	0.50	4.94	0.96	-0.21	0.97	0.55	0.80	13.16	0.89	-0.55	0.98	0.65	0.99	15.64	0.83	0.65
17219	0.91	0.31	1.08	7.21	0.86	-0.31	0.90	0.54	1.29	12.52	0.81	-0.54	0.98	0.68	1.47	15.85	0.75	0.68
17220	0.98	0.53	0.66	12.96	0.91	-0.53	0.97	0.28	0.47	6.96	0.96	-0.28	0.97	0.42	0.69	10.24	0.90	0.42
17221	0.95	0.05	0.38	1.52	0.95	0.05	0.96	0.46	0.67	13.66	0.84	0.46	0.83	0.63	0.97	18.70	0.67	-0.63
17383	0.97	1.05	1.20	27.65	0.57	-1.05	0.97	0.06	0.39	1.67	0.95	0.06	0.95	0.04	0.40	1.08	0.95	0.04
17384	0.94	1.37	1.54	33.38	0.36	-1.37	0.96	0.29	0.49	7.07	0.94	-0.29	0.96	0.39	0.57	9.61	0.91	0.39
17439	0.87	0.98	1.27	25.89	0.53	-0.98	0.85	0.09	0.76	2.38	0.84	0.09	0.91	0.11	0.65	3.01	0.88	0.11
17440	0.91	0.69	1.02	17.45	0.76	-0.69	0.97	0.12	0.39	3.05	0.97	-0.12	0.98	0.25	0.45	6.30	0.95	0.25
17441	0.92	0.49	0.75	13.15	0.84	-0.49	0.97	0.05	0.35	1.22	0.96	0.05	0.96	0.03	0.35	0.89	0.96	0.03
17442	0.93	0.90	1.21	21.93	0.70	-0.90	0.96	0.23	0.52	5.70	0.95	-0.23	0.97	0.37	0.64	8.93	0.92	0.37
17443	0.48	0.20	1.08	7.19	0.42	-0.20	0.65	1.24	1.69	44.61	-0.42	1.24	0.61	0.73	1.22	26.49	0.26	-0.73
17444	0.89	0.61	1.01	16.23	0.76	-0.61	0.91	0.21	0.65	5.63	0.90	0.21	0.94	0.03	0.56	0.84	0.93	-0.03
17742	0.98	0.00	0.35	0.11	0.98	0.00	0.97	0.28	0.55	7.26	0.94	-0.28	0.98	0.31	0.63	8.10	0.93	0.31
17749	0.98	0.38	0.49	10.23	0.96	0.38	0.98	0.14	0.53	3.87	0.95	-0.14	0.99	0.28	0.67	7.47	0.92	0.28
17782	0.96	1.37	1.55	30.15	0.55	-1.37	0.95	0.85	1.03	18.64	0.80	-0.85	0.98	0.87	1.07	19.05	0.78	0.87
17787	0.98	0.29	0.44	7.47	0.96	-0.29	0.98	0.19	0.40	4.99	0.97	-0.19	0.98	0.27	0.51	6.93	0.94	0.27
17789	0.96	0.21	0.51	5.73	0.94	0.21	0.96	0.16	0.43	4.34	0.96	-0.16	0.95	0.26	0.62	7.05	0.91	0.26
17790	0.95	0.34	0.59	9.27	0.92	0.34	0.96	0.02	0.43	0.53	0.96	0.02	0.95	0.02	0.62	0.65	0.92	0.02
17822	0.98	1.06	1.19	31.57	0.68	1.06	0.98	0.34	0.46	10.01	0.95	0.34	0.97	0.26	0.50	7.86	0.94	-0.26
17854	0.97	0.85	1.05	25.70	0.65	0.85	0.96	0.30	0.48	9.01	0.93	0.30	0.93	0.29	0.56	8.64	0.90	-0.29
18028	0.97	0.88	1.03	21.38	0.75	-0.88	0.98	0.25	0.42	6.14	0.96	-0.25	0.97	0.39	0.56	9.44	0.93	0.39
18030	0.98	0.49	0.61	12.51	0.94	0.49	0.98	0.05	0.51	1.33	0.96	0.05	0.98	0.20	0.71	5.22	0.92	0.20
18031	0.91	0.16	0.77	3.96	0.90	-0.16	0.90	0.46	0.90	11.01	0.86	-0.46	0.96	0.68	1.15	16.44	0.77	0.68
18032	0.97	0.81	0.88	20.24	0.80	-0.81	0.98	0.28	0.40	6.90	0.96	-0.28	0.97	0.45	0.62	11.18	0.90	0.45
18034	0.99	0.59	0.66	16.24	0.92	0.59	0.98	0.13	0.48	3.43	0.96	0.13	0.98	0.11	0.67	3.04	0.92	0.11
18035	0.98	0.84	0.95	25.02	0.79	0.84	0.99	0.35	0.45	10.49	0.95	0.35	0.98	0.30	0.46	9.00	0.95	-0.30
18038	0.97	0.08	0.44	2.04	0.96	-0.08	0.97	0.02	0.46	0.52	0.96	0.02	0.98	0.07	0.50	1.93	0.95	0.07
18049	0.79	0.72	1.40	19.43	0.69	0.72	0.79	0.15	1.17	4.07	0.78	0.15	0.87	0.08	1.51	2.22	0.64	0.08
18050	0.97	0.59	0.72	13.28	0.90	-0.59	0.96	0.55	0.72	12.33	0.89	-0.55	0.98	0.67	0.88	14.89	0.84	0.67
18441	0.99	1.33	1.48	41.97	0.44	1.33	0.98	0.61	0.67	19.22	0.89	0.61	0.95	0.54	0.71	16.95	0.87	-0.54
18443	0.97	0.48	0.75	11.20	0.91	-0.48	0.97	0.54	0.85	12.71	0.89	-0.54	0.99	0.72	1.09	16.96	0.81	0.72
18444	0.98	0.01	0.26	0.19	0.98	-0.01	0.98	0.16	0.35	4.59	0.96	0.16	0.96	0.14	0.40	3.78	0.95	-0.14
18445	0.89	0.39	0.87	11.99	0.83	-0.39	0.85	0.03	0.85	1.00	0.84	-0.03	0.94	0.14	0.74	4.17	0.88	0.14
18446	0.98	0.03	0.38	0.62	0.97	-0.03	0.97	0.12	0.50	2.97	0.96	-0.12	0.98	0.34	0.69	8.47	0.92	0.34
18447	0.99	0.94	1.03	28.36	0.76	0.94	0.98	0.36	0.47	10.80	0.95	0.36	0.95	0.15	0.63	4.45	0.91	-0.15
18448	0.98	0.73	0.90	17.40	0.86	-0.73	0.98	0.54	0.74	12.87	0.90	-0.54	0.98	0.71	0.98	16.96	0.83	0.71
18450	0.98	0.56	0.68	14.28	0.90	-0.56	0.98	0.29	0.44	7.27	0.96	-0.29	0.98	0.50	0.71	12.57	0.89	0.50
18901	0.98	0.43	0.66	11.90	0.91	-0.43	0.97	0.20	0.58	5.61	0.93	-0.20	0.98	0.32	0.62	8.76	0.92	0.32

Calibration with constant K coefficients (LR)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.17	0.73	4.28	0.87	0.17	0.92	0.26	0.76	6.62	0.86	-0.26	0.88	0.22	0.97	5.54	0.77	0.22
17180	0.96	0.10	0.38	2.96	0.96	0.10	0.96	0.49	0.93	14.96	0.75	0.49	0.86	0.61	0.93	18.45	0.75	-0.61
17218	0.93	0.20	0.66	4.87	0.92	-0.20	0.94	0.55	0.81	13.28	0.89	-0.55	0.95	0.66	1.32	15.83	0.69	0.66

17219	0.85	0.31	1.27	7.14	0.81	-0.31	0.86	0.54	1.25	12.59	0.82	-0.54	0.95	0.77	1.99	17.82	0.53	0.77
17220	0.96	0.53	0.74	12.92	0.89	-0.53	0.96	0.29	0.61	6.99	0.92	-0.29	0.94	0.40	0.94	9.87	0.82	0.40
17221	0.93	0.05	0.46	1.56	0.92	0.05	0.96	0.44	0.93	13.20	0.69	0.44	0.79	0.64	1.00	19.23	0.64	-0.64
17383	0.94	1.05	1.24	27.78	0.54	-1.05	0.96	0.03	0.70	0.86	0.86	0.03	0.93	0.02	0.52	0.50	0.92	0.02
17384	0.89	1.38	1.60	33.59	0.31	-1.38	0.94	0.33	0.75	8.12	0.85	-0.33	0.94	0.40	0.77	9.79	0.84	0.40
17439	0.83	0.99	1.32	26.00	0.50	-0.99	0.84	0.06	0.95	1.66	0.74	0.06	0.90	0.11	0.78	2.90	0.83	0.11
17440	0.83	0.68	1.15	17.34	0.70	-0.68	0.95	0.16	0.59	4.03	0.92	-0.16	0.94	0.26	0.80	6.72	0.86	0.26
17441	0.88	0.49	0.83	13.13	0.80	-0.49	0.96	0.01	0.63	0.22	0.88	0.01	0.93	0.01	0.51	0.34	0.92	0.01
17442	0.88	0.90	1.28	21.93	0.67	-0.90	0.94	0.26	0.66	6.27	0.91	-0.26	0.94	0.36	0.91	8.79	0.83	0.36
17443	0.47	0.20	1.09	7.23	0.41	-0.20	0.65	1.18	1.88	42.57	-0.76	1.18	0.61	0.74	1.26	26.56	0.21	-0.74
17444	0.84	0.61	1.09	16.26	0.72	-0.61	0.91	0.19	0.77	4.97	0.86	0.19	0.92	0.03	0.75	0.80	0.87	-0.03
17742	0.95	0.00	0.54	0.05	0.95	0.00	0.95	0.27	0.58	7.23	0.94	-0.27	0.95	0.32	0.96	8.49	0.83	0.32
17749	0.94	0.38	0.67	10.24	0.92	0.38	0.96	0.16	0.51	4.39	0.95	-0.16	0.95	0.30	1.07	8.25	0.79	0.30
17782	0.91	1.38	1.63	30.24	0.50	-1.38	0.91	0.88	1.12	19.24	0.76	-0.88	0.95	0.89	1.39	19.60	0.63	0.89
17787	0.95	0.29	0.59	7.48	0.93	-0.29	0.96	0.20	0.55	5.25	0.93	-0.20	0.94	0.27	0.84	6.97	0.85	0.27
17789	0.94	0.22	0.61	5.75	0.91	0.22	0.95	0.17	0.57	4.64	0.92	-0.17	0.92	0.25	0.87	6.80	0.82	0.25
17790	0.92	0.34	0.72	9.33	0.89	0.34	0.94	0.02	0.61	0.55	0.92	0.02	0.91	0.05	0.94	1.42	0.81	0.05
17822	0.98	1.05	1.17	31.35	0.69	1.05	0.98	0.32	0.53	9.53	0.94	0.32	0.93	0.26	0.72	7.68	0.88	-0.26
17854	0.97	0.85	1.01	25.55	0.68	0.85	0.97	0.28	0.66	8.53	0.87	0.28	0.90	0.31	0.66	9.34	0.87	-0.31
18028	0.92	0.86	1.10	21.10	0.72	-0.86	0.96	0.27	0.60	6.64	0.92	-0.27	0.95	0.34	0.71	8.40	0.88	0.34
18030	0.94	0.50	0.81	12.82	0.90	0.50	0.96	0.04	0.49	1.00	0.96	0.04	0.95	0.22	1.15	5.72	0.79	0.22
18031	0.86	0.15	0.91	3.66	0.86	-0.15	0.89	0.46	0.93	11.12	0.85	-0.46	0.92	0.67	1.48	16.24	0.62	0.67
18032	0.97	0.81	0.89	20.15	0.80	-0.81	0.97	0.29	0.57	7.26	0.92	-0.29	0.95	0.39	0.71	9.75	0.87	0.39
18034	0.95	0.60	0.80	16.43	0.89	0.60	0.96	0.11	0.47	2.99	0.96	0.11	0.94	0.15	1.12	4.08	0.78	0.15
18035	0.95	0.84	1.02	25.22	0.76	0.84	0.97	0.33	0.54	9.94	0.93	0.33	0.93	0.29	0.75	8.62	0.87	-0.29
18038	0.93	0.07	0.64	1.77	0.92	-0.07	0.95	0.01	0.54	0.25	0.95	0.01	0.94	0.09	0.91	2.37	0.84	0.09
18049	0.76	0.72	1.47	19.37	0.66	0.72	0.77	0.12	1.26	3.31	0.75	0.12	0.83	0.14	2.00	3.87	0.37	0.14
18050	0.93	0.59	0.84	13.22	0.86	-0.59	0.93	0.57	0.87	12.76	0.85	-0.57	0.94	0.66	1.22	14.87	0.70	0.66
18441	0.99	1.32	1.45	41.79	0.45	1.32	0.98	0.58	0.78	18.46	0.84	0.58	0.90	0.53	0.84	16.60	0.82	-0.53
18443	0.93	0.47	0.92	11.17	0.87	-0.47	0.95	0.56	0.82	13.26	0.90	-0.56	0.96	0.74	1.48	17.47	0.66	0.74
18444	0.96	0.01	0.38	0.13	0.96	-0.01	0.98	0.14	0.60	3.78	0.90	0.14	0.95	0.17	0.46	4.84	0.94	-0.17
18445	0.86	0.39	0.95	12.18	0.80	-0.39	0.83	0.07	0.90	2.00	0.82	-0.07	0.94	0.17	0.93	5.30	0.81	0.17
18446	0.96	0.03	0.48	0.75	0.96	-0.03	0.97	0.15	0.49	3.64	0.96	-0.15	0.95	0.32	0.98	8.06	0.83	0.32
18447	0.97	0.93	1.05	28.12	0.75	0.93	0.96	0.33	0.59	9.93	0.92	0.33	0.90	0.10	0.98	2.97	0.78	-0.10
18448	0.95	0.73	0.98	17.45	0.83	-0.73	0.96	0.56	0.73	13.46	0.91	-0.56	0.97	0.69	1.20	16.58	0.74	0.69
18450	0.96	0.57	0.74	14.32	0.88	-0.57	0.97	0.31	0.54	7.89	0.94	-0.31	0.95	0.48	0.92	12.06	0.81	0.48
18901	0.95	0.43	0.76	11.89	0.88	-0.43	0.95	0.21	0.55	5.85	0.94	-0.21	0.95	0.32	0.92	8.88	0.83	0.32

Calibration with monthly A and B coefficients (LR)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.93	0.00	0.56	0.09	0.92	0.00	0.94	0.23	0.56	5.82	0.92	-0.23	0.99	0.03	0.16	0.76	0.99	0.03
17180	0.97	0.24	0.42	7.32	0.95	0.24	0.97	0.46	0.62	14.02	0.89	0.46	1.00	0.05	0.15	1.51	0.99	-0.05
17218	0.97	0.33	0.59	7.94	0.94	-0.33	0.97	0.53	0.76	12.64	0.90	-0.53	1.00	0.04	0.15	0.89	1.00	0.04
17219	0.91	0.46	1.18	10.51	0.84	-0.46	0.91	0.57	1.29	13.27	0.81	-0.57	1.00	0.06	0.16	1.36	1.00	-0.06
17220	0.98	0.46	0.61	11.33	0.92	-0.46	0.98	0.33	0.49	7.95	0.95	-0.33	1.00	0.02	0.10	0.41	1.00	-0.02
17221	0.96	0.19	0.43	5.56	0.94	0.19	0.97	0.41	0.63	12.11	0.86	0.41	0.99	0.07	0.16	2.17	0.99	-0.07
17383	0.97	0.59	0.68	15.69	0.86	-0.59	0.97	0.02	0.36	0.43	0.96	-0.02	1.00	0.00	0.12	0.02	1.00	0.00
17384	0.96	0.91	1.01	22.13	0.73	-0.91	0.97	0.36	0.51	8.72	0.93	-0.36	1.00	0.01	0.14	0.23	1.00	0.01
17439	0.90	0.54	0.81	14.27	0.81	-0.54	0.88	0.02	0.69	0.47	0.86	0.02	0.99	0.07	0.17	1.74	0.99	0.07

17440	0.96	0.48	0.69	12.17	0.89	-0.48	0.98	0.20	0.38	4.95	0.97	-0.20	1.00	0.01	0.12	0.12	1.00	-0.01
17441	0.96	0.28	0.46	7.67	0.94	-0.28	0.98	0.01	0.33	0.24	0.97	-0.01	1.00	0.02	0.12	0.43	1.00	0.02
17442	0.96	0.68	0.91	16.63	0.83	-0.68	0.97	0.32	0.54	7.88	0.94	-0.32	1.00	0.06	0.12	1.44	1.00	-0.06
17443	0.64	0.32	1.01	11.57	0.49	0.32	0.68	1.07	1.57	38.65	-0.23	1.07	0.96	0.19	0.37	6.77	0.93	0.19
17444	0.93	0.31	0.67	8.17	0.89	-0.31	0.93	0.12	0.55	3.04	0.93	0.12	1.00	0.01	0.13	0.15	1.00	-0.01
17742	0.98	0.05	0.38	1.20	0.97	-0.05	0.98	0.21	0.50	5.49	0.95	-0.21	1.00	0.06	0.12	1.56	1.00	0.06
17749	0.98	0.19	0.43	5.22	0.97	0.19	0.98	0.11	0.50	2.93	0.96	-0.11	1.00	0.07	0.15	1.94	1.00	0.07
17782	0.96	1.15	1.30	25.15	0.68	-1.15	0.96	0.88	1.03	19.24	0.80	-0.88	1.00	0.03	0.15	0.74	1.00	-0.03
17787	0.98	0.24	0.39	6.25	0.97	-0.24	0.98	0.20	0.38	5.06	0.97	-0.20	1.00	0.03	0.07	0.64	1.00	0.03
17789	0.96	0.10	0.44	2.57	0.95	0.10	0.97	0.13	0.36	3.49	0.97	-0.13	0.98	0.10	0.30	2.56	0.98	0.10
17790	0.96	0.19	0.49	5.29	0.95	0.19	0.96	0.03	0.43	0.75	0.96	0.03	1.00	0.02	0.15	0.49	1.00	0.02
17822	0.98	0.70	0.78	20.94	0.86	0.70	0.98	0.32	0.44	9.60	0.96	0.32	1.00	0.02	0.10	0.66	1.00	0.02
17854	0.97	0.61	0.79	18.33	0.81	0.61	0.97	0.32	0.49	9.63	0.92	0.32	1.00	0.07	0.17	2.14	0.99	0.07
18028	0.98	0.65	0.76	15.82	0.87	-0.65	0.98	0.33	0.45	8.12	0.95	-0.33	1.00	0.03	0.11	0.66	1.00	-0.03
18030	0.98	0.15	0.46	3.90	0.97	0.15	0.98	0.07	0.52	1.67	0.96	-0.07	1.00	0.07	0.11	1.91	1.00	-0.07
18031	0.92	0.31	0.77	7.56	0.90	-0.31	0.93	0.47	0.83	11.24	0.88	-0.47	0.98	0.04	0.33	1.06	0.98	0.04
18032	0.98	0.58	0.66	14.33	0.89	-0.58	0.98	0.31	0.41	7.79	0.96	-0.31	1.00	0.04	0.10	1.08	1.00	0.04
18034	0.98	0.33	0.47	9.01	0.96	0.33	0.99	0.08	0.45	2.09	0.96	0.08	1.00	0.02	0.10	0.67	1.00	0.02
18035	0.98	0.60	0.67	17.81	0.90	0.60	0.99	0.33	0.40	9.72	0.96	0.33	1.00	0.01	0.09	0.26	1.00	0.01
18038	0.98	0.06	0.43	1.63	0.97	-0.06	0.98	0.02	0.43	0.54	0.97	-0.02	1.00	0.03	0.09	0.72	1.00	-0.03
18049	0.78	0.33	1.22	8.77	0.77	0.33	0.78	0.04	1.18	1.07	0.78	0.04	0.95	0.00	0.63	0.10	0.94	0.00
18050	0.97	0.70	0.81	15.59	0.87	-0.70	0.96	0.66	0.79	14.78	0.87	-0.66	1.00	0.08	0.13	1.81	1.00	-0.08
18441	0.99	0.93	1.01	29.26	0.74	0.93	0.98	0.55	0.61	17.52	0.90	0.55	1.00	0.01	0.12	0.24	1.00	-0.01
18443	0.97	0.53	0.81	12.48	0.90	-0.53	0.97	0.57	0.86	13.39	0.89	-0.57	1.00	0.01	0.10	0.33	1.00	-0.01
18444	0.98	0.03	0.28	0.78	0.98	0.03	0.98	0.12	0.33	3.33	0.97	0.12	1.00	0.01	0.08	0.34	1.00	-0.01
18445	0.87	0.02	0.78	0.45	0.87	0.02	0.87	0.12	0.80	3.68	0.86	0.12	0.99	0.27	0.37	8.35	0.97	0.27
18446	0.98	0.18	0.44	4.51	0.97	-0.18	0.98	0.21	0.51	5.31	0.96	-0.21	1.00	0.06	0.12	1.46	1.00	-0.06
18447	0.99	0.64	0.70	19.37	0.89	0.64	0.98	0.33	0.44	10.03	0.96	0.33	1.00	0.08	0.19	2.30	0.99	0.08
18448	0.98	0.63	0.81	15.04	0.88	-0.63	0.98	0.54	0.73	12.98	0.91	-0.54	1.00	0.03	0.11	0.66	1.00	0.03
18450	0.98	0.43	0.56	10.94	0.93	-0.43	0.98	0.30	0.44	7.60	0.96	-0.30	1.00	0.07	0.11	1.69	1.00	0.07
18901	0.98	0.16	0.49	4.32	0.95	-0.16	0.98	0.09	0.47	2.44	0.96	-0.09	1.00	0.17	0.22	4.77	0.99	0.17

Calibration with constanr A and B coefficients (LR)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.14	0.65	3.63	0.90	0.14	0.92	0.25	0.62	6.37	0.91	-0.25	0.88	0.08	0.71	2.01	0.87	0.08
17180	0.96	0.12	0.41	3.64	0.95	0.12	0.96	0.48	0.65	14.59	0.87	0.48	0.86	0.27	0.97	8.11	0.72	-0.27
17218	0.93	0.22	0.70	5.30	0.91	-0.22	0.94	0.54	0.89	12.89	0.86	-0.54	0.95	0.29	0.62	6.95	0.93	0.29
17219	0.85	0.33	1.34	7.67	0.79	-0.33	0.86	0.55	1.42	12.84	0.76	-0.55	0.95	0.32	0.75	7.31	0.93	0.32
17220	0.96	0.52	0.79	12.67	0.87	-0.52	0.96	0.30	0.56	7.39	0.94	-0.30	0.94	0.15	0.63	3.55	0.92	0.15
17221	0.93	0.07	0.46	2.19	0.93	0.07	0.96	0.43	0.65	12.77	0.85	0.43	0.79	0.31	1.00	9.33	0.65	-0.31
17383	0.94	0.98	1.23	26.00	0.55	-0.98	0.96	0.01	0.42	0.37	0.95	0.01	0.93	0.01	0.68	0.32	0.86	-0.01
17384	0.89	1.31	1.57	31.92	0.34	-1.31	0.94	0.34	0.60	8.35	0.90	-0.34	0.94	0.14	0.59	3.44	0.91	0.14
17439	0.83	0.93	1.31	24.37	0.51	-0.93	0.84	0.04	0.77	0.97	0.83	0.04	0.90	0.05	0.66	1.18	0.88	0.05
17440	0.83	0.65	1.16	16.54	0.69	-0.65	0.95	0.17	0.52	4.33	0.94	-0.17	0.94	0.10	0.59	2.60	0.92	0.10
17441	0.88	0.45	0.84	12.21	0.79	-0.45	0.96	0.01	0.39	0.24	0.96	0.01	0.93	0.01	0.66	0.33	0.87	0.01
17442	0.88	0.87	1.30	21.09	0.66	-0.87	0.94	0.28	0.62	6.87	0.92	-0.28	0.94	0.11	0.61	2.68	0.92	0.11
17443	0.47	0.12	1.06	4.40	0.45	-0.12	0.65	1.14	1.62	41.03	-0.30	1.14	0.61	0.18	0.91	6.64	0.59	-0.18
17444	0.84	0.58	1.11	15.25	0.71	-0.58	0.91	0.14	0.65	3.80	0.90	0.14	0.92	0.04	0.67	1.11	0.89	-0.04
17742	0.95	0.01	0.57	0.21	0.94	-0.01	0.95	0.24	0.65	6.37	0.92	-0.24	0.95	0.19	0.60	4.93	0.93	0.19

17749	0.94	0.35	0.68	9.59	0.92	0.35	0.96	0.13	0.65	3.47	0.92	-0.13	0.95	0.21	0.59	5.82	0.94	0.21
17782	0.91	1.34	1.64	29.44	0.49	-1.34	0.91	0.87	1.14	19.12	0.75	-0.87	0.95	0.32	0.61	6.99	0.93	0.32
17787	0.95	0.28	0.63	7.25	0.91	-0.28	0.96	0.20	0.49	5.05	0.95	-0.20	0.94	0.13	0.63	3.32	0.91	0.13
17789	0.94	0.20	0.56	5.29	0.93	0.20	0.95	0.15	0.47	3.98	0.95	-0.15	0.92	0.16	0.65	4.28	0.90	0.16
17790	0.92	0.32	0.70	8.78	0.90	0.32	0.94	0.03	0.54	0.69	0.94	0.03	0.91	0.05	0.70	1.40	0.90	0.05
17822	0.98	1.00	1.07	29.93	0.74	1.00	0.98	0.33	0.49	9.76	0.95	0.33	0.93	0.05	0.68	1.57	0.90	-0.05
17854	0.97	0.82	0.92	24.61	0.73	0.82	0.97	0.30	0.45	9.10	0.94	0.30	0.90	0.08	0.76	2.36	0.82	-0.08
18028	0.92	0.83	1.11	20.29	0.71	-0.83	0.96	0.29	0.51	7.13	0.94	-0.29	0.95	0.10	0.59	2.51	0.92	0.10
18030	0.94	0.45	0.80	11.61	0.90	0.45	0.96	0.00	0.63	0.00	0.94	0.00	0.95	0.09	0.61	2.27	0.94	0.09
18031	0.86	0.17	0.94	4.14	0.85	-0.17	0.89	0.46	0.95	11.05	0.84	-0.46	0.92	0.31	0.73	7.34	0.91	0.31
18032	0.97	0.78	0.88	19.30	0.80	-0.78	0.97	0.30	0.44	7.35	0.95	-0.30	0.95	0.16	0.59	3.95	0.91	0.16
18034	0.95	0.56	0.79	15.45	0.89	0.56	0.96	0.10	0.60	2.85	0.94	0.10	0.94	0.13	0.61	3.45	0.93	0.13
18035	0.95	0.81	0.96	24.23	0.79	0.81	0.97	0.34	0.50	10.11	0.94	0.34	0.93	0.07	0.68	2.17	0.89	-0.07
18038	0.93	0.06	0.70	1.71	0.91	-0.06	0.95	0.00	0.59	0.05	0.93	0.00	0.94	0.05	0.64	1.30	0.92	0.05
18049	0.76	0.67	1.42	18.02	0.68	0.67	0.77	0.10	1.23	2.68	0.76	0.10	0.83	0.09	1.11	2.50	0.81	0.09
18050	0.93	0.60	0.87	13.49	0.85	-0.60	0.93	0.60	0.85	13.51	0.85	-0.60	0.94	0.19	0.61	4.33	0.92	0.19
18441	0.99	1.27	1.34	40.10	0.53	1.27	0.98	0.58	0.64	18.25	0.89	0.58	0.90	0.17	0.80	5.42	0.83	-0.17
18443	0.93	0.48	0.99	11.27	0.85	-0.48	0.95	0.56	0.96	13.13	0.86	-0.56	0.96	0.32	0.62	7.55	0.94	0.32
18444	0.96	0.01	0.39	0.14	0.96	0.01	0.98	0.14	0.30	3.78	0.97	0.14	0.95	0.07	0.73	2.00	0.84	-0.07
18445	0.86	0.33	0.97	10.32	0.79	-0.33	0.83	0.03	0.93	0.93	0.81	0.03	0.94	0.27	0.64	8.43	0.91	0.27
18446	0.96	0.05	0.55	1.17	0.95	-0.05	0.97	0.17	0.56	4.21	0.94	-0.17	0.95	0.12	0.58	3.10	0.94	0.12
18447	0.97	0.89	0.98	27.01	0.79	0.89	0.96	0.34	0.55	10.28	0.93	0.34	0.90	0.07	0.70	1.95	0.89	0.07
18448	0.95	0.71	1.02	17.02	0.81	-0.71	0.96	0.55	0.82	13.06	0.88	-0.55	0.97	0.31	0.57	7.40	0.94	0.31
18450	0.96	0.54	0.77	13.75	0.87	-0.54	0.97	0.30	0.52	7.58	0.94	-0.30	0.95	0.24	0.59	6.06	0.92	0.24
18901	0.95	0.39	0.82	10.86	0.87	-0.39	0.95	0.16	0.67	4.31	0.91	-0.16	0.95	0.25	0.59	6.94	0.93	0.25

Calibration with monthly K coefficients (GD)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.94	0.08	0.62	2.09	0.90	0.08	0.94	0.32	0.60	8.12	0.91	-0.32	0.92	0.24	0.66	6.11	0.89	-0.24
17180	0.96	0.03	0.35	0.97	0.96	0.03	0.97	0.44	0.64	13.26	0.88	0.44	0.89	0.90	1.16	27.50	0.60	-0.90
17218	0.97	0.28	0.53	6.82	0.95	-0.28	0.97	0.60	0.83	14.31	0.88	-0.60	0.98	0.10	0.50	2.49	0.96	0.10
17219	0.91	0.39	1.11	9.05	0.86	-0.39	0.90	0.59	1.31	13.66	0.80	-0.59	0.97	0.13	0.95	2.89	0.90	0.13
17220	0.98	0.60	0.73	14.71	0.89	-0.60	0.97	0.33	0.50	8.18	0.95	-0.33	0.97	0.10	0.40	2.38	0.97	-0.10
17221	0.95	0.02	0.38	0.58	0.95	-0.02	0.96	0.41	0.65	12.13	0.85	0.41	0.83	0.94	1.23	28.03	0.46	-0.94
17383	0.97	1.10	1.25	29.18	0.53	-1.10	0.97	0.01	0.39	0.27	0.95	0.01	0.96	0.40	0.58	10.52	0.90	-0.40
17384	0.94	1.42	1.59	34.78	0.31	-1.42	0.96	0.34	0.52	8.37	0.93	-0.34	0.97	0.12	0.36	2.87	0.97	-0.12
17439	0.87	1.04	1.32	27.45	0.50	-1.04	0.85	0.04	0.75	0.98	0.84	0.04	0.91	0.33	0.65	8.76	0.88	-0.33
17440	0.91	0.76	1.07	19.19	0.74	-0.76	0.97	0.17	0.40	4.40	0.96	-0.17	0.98	0.23	0.36	5.76	0.97	-0.23
17441	0.92	0.55	0.79	14.99	0.82	-0.55	0.97	0.01	0.35	0.19	0.96	-0.01	0.97	0.40	0.55	10.69	0.91	-0.40
17442	0.93	0.97	1.26	23.56	0.68	-0.97	0.96	0.29	0.54	6.98	0.94	-0.29	0.97	0.15	0.40	3.52	0.97	-0.15
17443	0.49	0.26	1.08	9.19	0.42	-0.26	0.65	1.18	1.65	42.52	-0.36	1.18	0.61	0.97	1.33	34.86	0.12	-0.97
17444	0.89	0.68	1.05	17.93	0.74	-0.68	0.91	0.16	0.63	4.20	0.91	0.16	0.94	0.46	0.67	12.15	0.89	-0.46
17742	0.98	0.08	0.36	2.09	0.98	-0.08	0.97	0.32	0.57	8.47	0.94	-0.32	0.98	0.16	0.38	4.18	0.97	-0.16
17749	0.98	0.30	0.43	8.02	0.97	0.30	0.98	0.19	0.53	5.18	0.95	-0.19	0.99	0.17	0.42	4.72	0.97	-0.17
17782	0.96	1.44	1.61	31.59	0.51	-1.44	0.95	0.90	1.07	19.76	0.78	-0.90	0.98	0.25	0.46	5.52	0.96	0.25
17787	0.98	0.36	0.49	9.35	0.95	-0.36	0.98	0.24	0.42	6.25	0.96	-0.24	0.98	0.20	0.38	5.27	0.97	-0.20
17789	0.96	0.14	0.48	3.62	0.94	0.14	0.96	0.21	0.45	5.62	0.95	-0.21	0.96	0.19	0.48	5.20	0.94	-0.19
17790	0.95	0.26	0.55	7.08	0.94	0.26	0.96	0.03	0.43	0.78	0.96	-0.03	0.95	0.39	0.65	10.72	0.91	-0.39
17822	0.98	0.97	1.10	28.94	0.73	0.97	0.98	0.29	0.42	8.53	0.96	0.29	0.97	0.61	0.73	18.34	0.88	-0.61

17854	0.97	0.77	0.98	23.16	0.70	0.77	0.97	0.25	0.45	7.54	0.94	0.25	0.93	0.63	0.82	19.13	0.79	-0.63
18028	0.97	0.94	1.09	22.99	0.73	-0.94	0.98	0.30	0.45	7.43	0.95	-0.30	0.98	0.13	0.32	3.19	0.98	-0.13
18030	0.98	0.40	0.54	10.24	0.95	0.40	0.98	0.00	0.49	0.03	0.96	0.00	0.98	0.26	0.51	6.74	0.96	-0.26
18031	0.91	0.25	0.79	5.91	0.89	-0.25	0.91	0.51	0.92	12.19	0.85	-0.51	0.96	0.13	0.69	3.12	0.92	0.13
18032	0.97	0.88	0.94	21.82	0.78	-0.88	0.98	0.33	0.43	8.16	0.95	-0.33	0.98	0.07	0.31	1.69	0.98	-0.07
18034	0.99	0.50	0.58	13.91	0.94	0.50	0.98	0.07	0.46	2.03	0.96	0.07	0.98	0.31	0.55	8.60	0.95	-0.31
18035	0.98	0.75	0.87	22.51	0.83	0.75	0.99	0.30	0.40	8.99	0.96	0.30	0.97	0.65	0.74	19.34	0.87	-0.65
18038	0.97	0.15	0.46	4.01	0.96	-0.15	0.97	0.03	0.45	0.83	0.96	-0.03	0.98	0.36	0.52	9.66	0.95	-0.36
18049	0.79	0.63	1.35	17.00	0.71	0.63	0.79	0.10	1.17	2.64	0.79	0.10	0.87	0.34	1.30	9.23	0.73	-0.34
18050	0.97	0.67	0.78	15.04	0.87	-0.67	0.96	0.60	0.76	13.52	0.88	-0.60	0.98	0.08	0.39	1.78	0.97	0.08
18441	0.99	1.24	1.39	39.12	0.50	1.24	0.98	0.56	0.62	17.59	0.90	0.56	0.94	0.84	0.98	26.41	0.75	-0.84
18443	0.97	0.55	0.81	13.01	0.90	-0.55	0.97	0.59	0.87	13.90	0.88	-0.59	0.99	0.16	0.54	3.66	0.96	0.16
18444	0.98	0.08	0.27	2.27	0.98	-0.08	0.98	0.11	0.33	3.15	0.97	0.11	0.97	0.53	0.69	14.90	0.86	-0.53
18445	0.89	0.44	0.90	13.75	0.82	-0.44	0.85	0.08	0.85	2.38	0.84	-0.08	0.95	0.25	0.60	7.63	0.92	-0.25
18446	0.98	0.11	0.40	2.63	0.97	-0.11	0.97	0.17	0.50	4.30	0.96	-0.17	0.98	0.16	0.40	3.95	0.97	-0.16
18447	0.99	0.85	0.94	25.77	0.80	0.85	0.98	0.31	0.43	9.27	0.96	0.31	0.95	0.50	0.72	15.18	0.88	-0.50
18448	0.98	0.80	0.96	19.08	0.84	-0.80	0.98	0.59	0.77	14.06	0.89	-0.59	0.99	0.15	0.42	3.55	0.97	0.15
18450	0.98	0.63	0.74	16.01	0.88	-0.63	0.98	0.34	0.47	8.54	0.95	-0.34	0.98	0.01	0.31	0.35	0.98	-0.01
18901	0.98	0.49	0.71	13.64	0.90	-0.49	0.97	0.25	0.59	6.87	0.93	-0.25	0.98	0.13	0.36	3.67	0.97	-0.13

Calibration with constant K coefficients (GD)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.10	0.69	2.45	0.88	0.10	0.92	0.46	0.79	11.68	0.85	-0.46	0.88	0.34	0.82	8.81	0.83	-0.34
17180	0.96	0.04	0.37	1.16	0.96	0.04	0.96	0.29	0.73	8.73	0.84	0.29	0.86	0.97	1.23	29.54	0.55	-0.97
17218	0.93	0.27	0.69	6.53	0.92	-0.27	0.94	0.75	0.96	17.97	0.84	-0.75	0.95	0.00	0.78	0.08	0.89	0.00
17219	0.85	0.38	1.30	8.77	0.80	-0.38	0.86	0.75	1.39	17.33	0.77	-0.75	0.95	0.08	1.28	1.80	0.81	0.08
17220	0.96	0.59	0.80	14.44	0.87	-0.59	0.96	0.49	0.69	12.03	0.90	-0.49	0.94	0.21	0.65	5.07	0.91	-0.21
17221	0.93	0.01	0.46	0.21	0.93	-0.01	0.96	0.24	0.75	7.07	0.80	0.24	0.79	1.01	1.30	30.21	0.40	-1.01
17383	0.94	1.10	1.29	29.04	0.50	-1.10	0.96	0.17	0.62	4.60	0.89	-0.17	0.93	0.50	0.70	13.16	0.85	-0.50
17384	0.89	1.42	1.64	34.75	0.27	-1.42	0.94	0.54	0.80	13.09	0.83	-0.54	0.94	0.21	0.55	5.14	0.92	-0.21
17439	0.83	1.04	1.37	27.29	0.46	-1.04	0.84	0.15	0.89	3.84	0.77	-0.15	0.90	0.42	0.76	11.09	0.84	-0.42
17440	0.83	0.74	1.19	18.78	0.68	-0.74	0.95	0.36	0.63	9.23	0.91	-0.36	0.94	0.31	0.62	7.79	0.91	-0.31
17441	0.88	0.54	0.87	14.65	0.78	-0.54	0.96	0.19	0.57	5.21	0.91	-0.19	0.93	0.49	0.69	13.30	0.86	-0.49
17442	0.88	0.96	1.33	23.30	0.64	-0.96	0.94	0.47	0.73	11.34	0.89	-0.47	0.94	0.25	0.65	6.01	0.92	-0.25
17443	0.47	0.25	1.09	8.85	0.41	-0.25	0.65	0.97	1.67	34.85	-0.39	0.97	0.61	1.01	1.38	36.55	0.06	-1.01
17444	0.84	0.67	1.13	17.72	0.69	-0.67	0.91	0.03	0.69	0.72	0.89	-0.03	0.92	0.54	0.81	14.29	0.85	-0.54
17742	0.95	0.07	0.55	1.80	0.94	-0.07	0.95	0.47	0.69	12.26	0.91	-0.47	0.95	0.24	0.66	6.26	0.92	-0.24
17749	0.94	0.31	0.64	8.31	0.93	0.31	0.96	0.35	0.61	9.57	0.93	-0.35	0.95	0.24	0.73	6.47	0.90	-0.24
17782	0.91	1.43	1.68	31.46	0.46	-1.43	0.91	1.08	1.28	23.61	0.69	-1.08	0.95	0.15	0.73	3.34	0.90	0.15
17787	0.95	0.35	0.63	9.10	0.91	-0.35	0.96	0.40	0.61	10.38	0.92	-0.40	0.94	0.29	0.65	7.57	0.91	-0.29
17789	0.94	0.15	0.57	3.90	0.92	0.15	0.95	0.37	0.60	9.81	0.91	-0.37	0.92	0.29	0.69	7.73	0.88	-0.29
17790	0.92	0.27	0.69	7.42	0.90	0.27	0.94	0.18	0.59	4.90	0.93	-0.18	0.91	0.45	0.85	12.37	0.85	-0.45
17822	0.98	0.97	1.08	29.05	0.74	0.97	0.98	0.12	0.38	3.60	0.97	0.12	0.93	0.68	0.87	20.23	0.83	-0.68
17854	0.97	0.77	0.94	23.35	0.73	0.77	0.97	0.09	0.50	2.65	0.92	0.09	0.90	0.72	0.93	21.67	0.73	-0.72
18028	0.92	0.92	1.15	22.48	0.69	-0.92	0.96	0.48	0.66	11.70	0.90	-0.48	0.95	0.26	0.52	6.34	0.94	-0.26
18030	0.94	0.42	0.76	10.84	0.91	0.42	0.96	0.17	0.52	4.47	0.96	-0.17	0.95	0.34	0.84	8.65	0.89	-0.34
18031	0.86	0.22	0.93	5.34	0.85	-0.22	0.89	0.66	1.03	15.93	0.82	-0.66	0.92	0.02	0.94	0.44	0.85	0.02
18032	0.97	0.87	0.94	21.55	0.77	-0.87	0.97	0.49	0.64	12.28	0.90	-0.49	0.95	0.21	0.49	5.17	0.94	-0.21
18034	0.95	0.52	0.75	14.39	0.90	0.52	0.96	0.09	0.48	2.59	0.96	-0.09	0.94	0.37	0.86	10.07	0.87	-0.37

18035	0.95	0.77	0.95	23.03	0.79	0.77	0.97	0.13	0.39	3.98	0.97	0.13	0.93	0.70	0.90	21.05	0.81	-0.70
18038	0.93	0.13	0.66	3.49	0.92	-0.13	0.95	0.19	0.55	5.18	0.94	-0.19	0.94	0.43	0.78	11.55	0.88	-0.43
18049	0.76	0.64	1.42	17.29	0.68	0.64	0.77	0.09	1.23	2.29	0.76	-0.09	0.83	0.38	1.60	10.25	0.60	-0.38
18050	0.93	0.66	0.89	14.74	0.84	-0.66	0.93	0.78	0.99	17.49	0.80	-0.78	0.94	0.03	0.72	0.75	0.89	-0.03
18441	0.99	1.24	1.36	39.31	0.52	1.24	0.98	0.38	0.57	12.05	0.92	0.38	0.90	0.88	1.08	27.94	0.70	-0.88
18443	0.93	0.54	0.97	12.72	0.86	-0.54	0.95	0.76	0.99	17.95	0.85	-0.76	0.96	0.06	0.86	1.49	0.89	0.06
18444	0.96	0.07	0.38	1.87	0.96	-0.07	0.98	0.07	0.47	1.84	0.94	-0.07	0.95	0.64	0.80	17.78	0.81	-0.64
18445	0.86	0.44	0.98	13.71	0.79	-0.44	0.83	0.24	0.92	7.31	0.81	-0.24	0.94	0.29	0.71	9.02	0.89	-0.29
18446	0.96	0.10	0.50	2.48	0.96	-0.10	0.97	0.35	0.57	8.86	0.94	-0.35	0.95	0.26	0.68	6.64	0.92	-0.26
18447	0.97	0.86	0.97	25.88	0.79	0.86	0.96	0.13	0.45	3.98	0.95	0.13	0.90	0.54	0.92	16.16	0.81	-0.54
18448	0.95	0.79	1.04	18.89	0.81	-0.79	0.96	0.76	0.89	18.15	0.86	-0.76	0.97	0.03	0.63	0.73	0.93	0.03
18450	0.96	0.62	0.80	15.82	0.86	-0.62	0.97	0.51	0.64	12.88	0.91	-0.51	0.95	0.13	0.56	3.18	0.93	-0.13
18901	0.95	0.48	0.81	13.43	0.87	-0.48	0.95	0.39	0.66	10.95	0.91	-0.39	0.95	0.21	0.62	5.92	0.92	-0.21

Calibration with monthly A and B coefficients (GD)

Sta-tion	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	**MAE**	**RMSE**	**PE**	**NSE**	**MBE**	**R2**	**MAE**	**RMSE**	**PE**	**NSE**	**MBE**	**R2**	**MAE**	**RMSE**	**PE**	**NSE**	**MBE**
9020	0.94	0.06	0.59	1.54	0.91	0.06	0.94	0.27	0.57	6.94	0.92	-0.27	0.99	0.00	0.18	0.00	0.99	0.00
17180	0.97	0.12	0.36	3.79	0.96	0.12	0.97	0.46	0.64	14.03	0.88	0.46	0.99	0.15	0.26	4.51	0.98	-0.15
17218	0.97	0.29	0.54	7.01	0.95	-0.29	0.97	0.56	0.80	13.39	0.89	-0.56	1.00	0.06	0.16	1.33	1.00	0.06
17219	0.91	0.41	1.13	9.41	0.85	-0.41	0.90	0.57	1.30	13.20	0.80	-0.57	1.00	0.01	0.12	0.32	1.00	-0.01
17220	0.98	0.54	0.67	13.15	0.91	-0.54	0.97	0.32	0.49	7.79	0.95	-0.32	1.00	0.02	0.11	0.53	1.00	-0.02
17221	0.96	0.07	0.37	2.04	0.95	0.07	0.96	0.42	0.64	12.39	0.85	0.42	0.99	0.18	0.28	5.26	0.97	-0.18
17383	0.98	0.90	1.03	23.70	0.69	-0.90	0.97	0.01	0.38	0.18	0.96	0.01	1.00	0.05	0.13	1.27	1.00	-0.05
17384	0.95	1.21	1.36	29.63	0.50	-1.21	0.96	0.34	0.51	8.37	0.93	-0.34	1.00	0.01	0.13	0.17	1.00	-0.01
17439	0.89	0.84	1.11	22.09	0.65	-0.84	0.86	0.03	0.73	0.90	0.85	0.03	0.99	0.02	0.14	0.48	0.99	0.02
17440	0.93	0.64	0.93	16.33	0.80	-0.64	0.97	0.18	0.39	4.45	0.97	-0.18	1.00	0.03	0.11	0.65	1.00	-0.03
17441	0.94	0.44	0.66	11.99	0.87	-0.44	0.97	0.00	0.33	0.01	0.97	0.00	1.00	0.03	0.11	0.89	1.00	-0.03
17442	0.94	0.85	1.12	20.70	0.74	-0.85	0.96	0.29	0.54	7.11	0.94	-0.29	1.00	0.07	0.12	1.58	1.00	-0.07
17443	0.56	0.02	0.99	0.75	0.52	-0.02	0.66	1.14	1.62	40.98	-0.31	1.14	0.98	0.05	0.23	1.76	0.97	0.05
17444	0.91	0.53	0.90	13.99	0.81	-0.53	0.92	0.15	0.60	3.85	0.91	0.15	1.00	0.06	0.14	1.47	1.00	-0.06
17742	0.98	0.06	0.36	1.44	0.98	-0.06	0.98	0.26	0.54	6.93	0.94	-0.26	1.00	0.04	0.11	1.15	1.00	0.04
17749	0.98	0.26	0.42	7.17	0.97	0.26	0.98	0.14	0.53	3.88	0.95	-0.14	1.00	0.06	0.13	1.53	1.00	0.06
17782	0.96	1.31	1.48	28.81	0.58	-1.31	0.95	0.88	1.05	19.35	0.79	-0.88	1.00	0.00	0.12	0.07	1.00	0.00
17787	0.98	0.31	0.44	7.89	0.96	-0.31	0.98	0.21	0.40	5.46	0.97	-0.21	1.00	0.00	0.07	0.09	1.00	0.00
17789	0.96	0.13	0.46	3.45	0.95	0.13	0.97	0.17	0.40	4.45	0.96	-0.17	0.98	0.07	0.29	1.78	0.98	0.07
17790	0.96	0.24	0.52	6.64	0.94	0.24	0.96	0.01	0.43	0.21	0.96	0.01	1.00	0.02	0.16	0.56	1.00	-0.02
17822	0.98	0.88	0.98	26.16	0.78	0.88	0.98	0.31	0.43	9.33	0.96	0.31	1.00	0.04	0.11	1.25	1.00	-0.04
17854	0.97	0.71	0.91	21.55	0.74	0.71	0.97	0.29	0.46	8.61	0.93	0.29	0.99	0.01	0.15	0.29	0.99	-0.01
18028	0.97	0.82	0.95	19.99	0.79	-0.82	0.98	0.31	0.44	7.50	0.96	-0.31	1.00	0.04	0.12	0.94	1.00	-0.04
18030	0.98	0.31	0.48	7.89	0.96	0.31	0.98	0.02	0.49	0.38	0.96	-0.02	1.00	0.08	0.12	2.06	1.00	-0.08
18031	0.92	0.27	0.78	6.43	0.90	-0.27	0.92	0.48	0.88	11.57	0.87	-0.48	0.98	0.06	0.34	1.55	0.98	0.06
18032	0.98	0.74	0.81	18.50	0.83	-0.74	0.98	0.31	0.41	7.82	0.96	-0.31	1.00	0.03	0.09	0.73	1.00	0.03
18034	0.99	0.44	0.53	12.22	0.95	0.44	0.99	0.09	0.46	2.40	0.96	0.09	1.00	0.00	0.12	0.06	1.00	0.00
18035	0.98	0.70	0.80	20.95	0.85	0.70	0.99	0.32	0.41	9.60	0.96	0.32	1.00	0.06	0.10	1.69	1.00	-0.06
18038	0.98	0.11	0.45	2.83	0.96	-0.11	0.98	0.02	0.45	0.46	0.96	-0.02	1.00	0.06	0.10	1.46	1.00	-0.06
18049	0.79	0.52	1.29	13.94	0.74	0.52	0.79	0.09	1.17	2.42	0.78	0.09	0.95	0.03	0.67	0.88	0.93	-0.03
18050	0.97	0.67	0.78	15.02	0.88	-0.67	0.96	0.62	0.76	13.82	0.88	-0.62	1.00	0.06	0.11	1.31	1.00	-0.06
18441	0.99	1.12	1.25	35.54	0.59	1.12	0.98	0.57	0.62	17.93	0.90	0.57	1.00	0.10	0.15	3.07	0.99	-0.10
18443	0.97	0.53	0.81	12.61	0.90	-0.53	0.97	0.57	0.86	13.43	0.88	-0.57	1.00	0.02	0.10	0.43	1.00	0.02

18444	0.98	0.03	0.25	0.91	0.98	-0.03	0.98	0.13	0.33	3.49	0.97	0.13	1.00	0.07	0.12	2.07	1.00	-0.07
18445	0.88	0.25	0.83	7.73	0.85	-0.25	0.86	0.01	0.84	0.40	0.85	0.01	0.99	0.22	0.30	6.72	0.98	0.22
18446	0.98	0.12	0.40	3.12	0.97	-0.12	0.97	0.18	0.50	4.44	0.96	-0.18	1.00	0.06	0.13	1.52	1.00	-0.06
18447	0.99	0.78	0.86	23.58	0.84	0.78	0.98	0.33	0.44	9.94	0.96	0.33	1.00	0.02	0.18	0.64	0.99	0.02
18448	0.98	0.72	0.89	17.23	0.86	-0.72	0.98	0.56	0.75	13.38	0.90	-0.56	1.00	0.05	0.12	1.16	1.00	0.05
18450	0.98	0.54	0.66	13.74	0.91	-0.54	0.98	0.31	0.45	7.91	0.96	-0.31	1.00	0.06	0.11	1.54	1.00	0.06
18901	0.98	0.35	0.61	9.63	0.93	-0.35	0.97	0.18	0.56	4.86	0.94	-0.18	1.00	0.15	0.19	4.05	0.99	0.15

Calibration with constant A and B coefficients (GD)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.14	0.65	3.68	0.90	0.14	0.92	0.25	0.62	6.47	0.91	-0.25	0.88	0.07	0.71	1.88	0.87	0.07
17180	0.96	0.12	0.41	3.75	0.95	0.12	0.96	0.48	0.65	14.47	0.87	0.48	0.86	0.28	0.97	8.37	0.72	-0.28
17218	0.93	0.22	0.70	5.24	0.91	-0.22	0.94	0.54	0.89	12.99	0.86	-0.54	0.95	0.29	0.62	6.87	0.93	0.29
17219	0.85	0.33	1.34	7.62	0.79	-0.33	0.86	0.56	1.42	12.92	0.77	-0.56	0.95	0.31	0.76	7.25	0.93	0.31
17220	0.96	0.51	0.79	12.59	0.87	-0.51	0.96	0.31	0.56	7.48	0.94	-0.31	0.94	0.14	0.63	3.45	0.92	0.14
17221	0.93	0.08	0.46	2.30	0.92	0.08	0.96	0.42	0.65	12.66	0.85	0.42	0.79	0.32	1.00	9.58	0.65	-0.32
17383	0.94	0.98	1.22	25.86	0.55	-0.98	0.96	0.01	0.43	0.27	0.95	0.01	0.93	0.02	0.67	0.47	0.87	-0.02
17384	0.89	1.30	1.57	31.79	0.34	-1.30	0.94	0.35	0.60	8.44	0.90	-0.35	0.94	0.14	0.59	3.34	0.91	0.14
17439	0.83	0.92	1.31	24.23	0.51	-0.92	0.84	0.03	0.77	0.88	0.83	0.03	0.90	0.04	0.65	1.03	0.88	0.04
17440	0.83	0.65	1.16	16.43	0.69	-0.65	0.95	0.17	0.52	4.43	0.94	-0.17	0.94	0.10	0.58	2.48	0.92	0.10
17441	0.88	0.45	0.84	12.09	0.80	-0.45	0.96	0.01	0.39	0.13	0.96	0.01	0.93	0.01	0.66	0.17	0.87	0.01
17442	0.88	0.86	1.30	20.99	0.66	-0.86	0.94	0.29	0.62	6.95	0.92	-0.29	0.94	0.11	0.61	2.57	0.93	0.11
17443	0.47	0.12	1.06	4.19	0.45	-0.12	0.65	1.13	1.62	40.92	-0.31	1.13	0.61	0.19	0.91	7.00	0.59	-0.19
17444	0.84	0.57	1.11	15.14	0.71	-0.57	0.91	0.14	0.65	3.71	0.90	0.14	0.92	0.05	0.67	1.26	0.89	-0.05
17742	0.95	0.01	0.57	0.14	0.94	-0.01	0.95	0.25	0.65	6.49	0.92	-0.25	0.95	0.18	0.59	4.80	0.93	0.18
17749	0.94	0.35	0.68	9.65	0.92	0.35	0.96	0.13	0.65	3.59	0.93	-0.13	0.95	0.21	0.59	5.68	0.94	0.21
17782	0.91	1.34	1.63	29.34	0.49	-1.34	0.91	0.87	1.14	19.21	0.75	-0.87	0.95	0.32	0.61	6.95	0.93	0.32
17787	0.95	0.28	0.63	7.17	0.91	-0.28	0.96	0.20	0.49	5.15	0.95	-0.20	0.94	0.12	0.63	3.19	0.91	0.12
17789	0.94	0.20	0.56	5.35	0.93	0.20	0.95	0.15	0.47	4.09	0.95	-0.15	0.92	0.16	0.64	4.14	0.90	0.16
17790	0.92	0.32	0.70	8.84	0.90	0.32	0.94	0.02	0.54	0.58	0.94	0.02	0.91	0.05	0.70	1.24	0.90	0.05
17822	0.98	1.00	1.07	29.97	0.74	1.00	0.98	0.32	0.48	9.64	0.95	0.32	0.93	0.06	0.68	1.79	0.90	-0.06
17854	0.97	0.82	0.92	24.67	0.73	0.82	0.97	0.30	0.45	8.98	0.94	0.30	0.90	0.09	0.76	2.59	0.82	-0.09
18028	0.92	0.83	1.11	20.19	0.71	-0.83	0.96	0.30	0.51	7.22	0.94	-0.30	0.95	0.10	0.59	2.41	0.92	0.10
18030	0.94	0.45	0.80	11.64	0.90	0.45	0.96	0.00	0.62	0.08	0.94	0.00	0.95	0.08	0.61	2.14	0.94	0.08
18031	0.86	0.17	0.94	4.09	0.85	-0.17	0.89	0.46	0.95	11.14	0.84	-0.46	0.92	0.30	0.73	7.26	0.91	0.30
18032	0.97	0.77	0.87	19.20	0.81	-0.77	0.97	0.30	0.44	7.45	0.95	-0.30	0.95	0.16	0.58	3.84	0.91	0.16
18034	0.95	0.56	0.79	15.49	0.89	0.56	0.96	0.10	0.60	2.74	0.94	0.10	0.94	0.12	0.61	3.29	0.93	0.12
18035	0.95	0.81	0.96	24.28	0.79	0.81	0.97	0.33	0.50	9.99	0.94	0.33	0.93	0.08	0.68	2.39	0.89	-0.08
18038	0.93	0.06	0.70	1.63	0.91	-0.06	0.95	0.00	0.59	0.05	0.94	0.00	0.94	0.04	0.64	1.15	0.92	0.04
18049	0.76	0.67	1.42	18.05	0.68	0.67	0.77	0.10	1.23	2.59	0.76	0.10	0.83	0.09	1.11	2.35	0.81	0.09
18050	0.93	0.60	0.87	13.43	0.85	-0.60	0.93	0.61	0.86	13.58	0.85	-0.61	0.94	0.19	0.61	4.28	0.93	0.19
18441	0.99	1.27	1.34	40.13	0.53	1.27	0.98	0.57	0.64	18.13	0.89	0.57	0.90	0.18	0.80	5.69	0.83	-0.18
18443	0.93	0.48	0.99	11.20	0.85	-0.48	0.95	0.56	0.96	13.23	0.86	-0.56	0.96	0.32	0.62	7.48	0.94	0.32
18444	0.96	0.01	0.39	0.23	0.96	0.01	0.98	0.13	0.30	3.68	0.97	0.13	0.95	0.08	0.73	2.18	0.84	-0.08
18445	0.86	0.33	0.97	10.16	0.79	-0.33	0.83	0.03	0.92	0.77	0.81	0.03	0.94	0.27	0.63	8.23	0.91	0.27
18446	0.96	0.04	0.55	1.12	0.95	-0.04	0.97	0.17	0.56	4.30	0.94	-0.17	0.95	0.12	0.58	2.99	0.94	0.12
18447	0.97	0.90	0.98	27.05	0.78	0.90	0.96	0.34	0.54	10.16	0.93	0.34	0.90	0.06	0.69	1.74	0.89	0.06
18448	0.95	0.71	1.02	16.93	0.81	-0.71	0.96	0.55	0.82	13.16	0.88	-0.55	0.97	0.31	0.56	7.33	0.94	0.31
18450	0.96	0.54	0.77	13.66	0.87	-0.54	0.97	0.30	0.52	7.68	0.94	-0.30	0.95	0.24	0.59	5.95	0.92	0.24

18901	0.95	0.39	0.82	10.75	0.87	-0.39	0.95	0.16	0.67	4.43	0.91	-0.16	0.95	0.24	0.58	6.79	0.93	0.24

Supplementary Table S2. Error rates of the original equations and calibrated equations.

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.33	0.69	8.39	0.88	-0.33	0.92	0.83	1.00	21.13	0.75	-0.83	0.88	0.79	1.44	20.13	0.48	0.79
17180	0.96	0.31	0.54	9.55	0.91	-0.31	0.96	0.10	0.48	2.91	0.93	-0.10	0.86	0.24	0.75	7.18	0.83	-0.24
17218	0.93	0.68	0.99	16.42	0.83	-0.68	0.94	1.12	1.31	26.75	0.70	-1.12	0.95	1.33	2.05	31.84	0.25	1.33
17219	0.85	0.80	1.58	18.42	0.71	-0.80	0.86	1.13	1.71	26.18	0.66	-1.13	0.95	1.47	2.85	34.10	0.05	1.47
17220	0.96	0.96	1.16	23.49	0.72	-0.96	0.96	0.88	0.99	21.44	0.80	-0.88	0.94	1.02	1.56	25.05	0.50	1.02
17221	0.93	0.36	0.59	10.77	0.88	-0.36	0.96	0.15	0.54	4.39	0.90	-0.15	0.79	0.27	0.81	8.07	0.77	-0.27
17383	0.94	1.38	1.59	36.55	0.25	-1.38	0.96	0.56	0.71	14.81	0.85	-0.56	0.93	0.54	0.86	14.39	0.78	0.54
17384	0.89	1.71	1.94	41.65	-0.01	-1.71	0.94	0.92	1.04	22.40	0.71	-0.92	0.94	1.02	1.37	24.96	0.49	1.02
17439	0.83	1.33	1.64	34.99	0.23	-1.33	0.84	0.54	0.95	14.13	0.74	-0.54	0.90	0.65	1.19	17.12	0.59	0.65
17440	0.83	1.08	1.47	27.37	0.50	-1.08	0.95	0.75	0.89	18.95	0.82	-0.75	0.94	0.84	1.34	21.46	0.59	0.84
17441	0.88	0.88	1.15	23.68	0.61	-0.88	0.96	0.57	0.69	15.35	0.86	-0.57	0.93	0.53	0.84	14.21	0.79	0.53
17442	0.88	1.29	1.65	31.41	0.45	-1.29	0.94	0.86	1.02	20.83	0.79	-0.86	0.94	0.98	1.52	23.82	0.53	0.98
17443	0.47	0.51	1.16	18.49	0.33	-0.51	0.65	0.57	1.31	20.42	0.14	0.57	0.61	0.46	1.24	16.42	0.24	-0.46
17444	0.84	1.00	1.41	26.42	0.53	-1.00	0.91	0.43	0.76	11.34	0.86	-0.43	0.92	0.49	1.11	12.91	0.71	0.49
17742	0.95	0.46	0.77	12.19	0.89	-0.46	0.95	0.82	1.01	21.65	0.81	-0.82	0.95	0.89	1.55	23.48	0.55	0.89
17749	0.94	0.12	0.64	3.15	0.93	-0.12	0.96	0.71	0.94	19.25	0.84	-0.71	0.95	0.85	1.66	23.21	0.51	0.85
17782	0.91	1.76	2.03	38.71	0.22	-1.76	0.91	1.45	1.62	31.79	0.50	-1.45	0.95	1.65	2.20	36.13	0.07	1.65
17787	0.95	0.72	0.95	18.72	0.80	-0.72	0.96	0.77	0.89	19.97	0.83	-0.77	0.94	0.84	1.37	21.75	0.59	0.84
17789	0.94	0.27	0.58	7.09	0.92	-0.27	0.95	0.73	0.85	19.46	0.83	-0.73	0.92	0.81	1.37	21.55	0.54	0.81
17790	0.92	0.14	0.64	3.95	0.91	-0.14	0.94	0.55	0.77	15.08	0.88	-0.55	0.91	0.57	1.35	15.44	0.61	0.57
17822	0.98	0.52	0.61	15.40	0.92	0.52	0.98	0.25	0.43	7.49	0.96	-0.25	0.93	0.17	0.93	5.08	0.81	0.17
17854	0.97	0.34	0.49	10.30	0.92	0.34	0.97	0.28	0.45	8.33	0.94	-0.28	0.90	0.11	0.68	3.19	0.86	0.11
18028	0.92	1.26	1.48	30.68	0.49	-1.26	0.96	0.87	0.96	21.15	0.79	-0.87	0.95	0.96	1.31	23.38	0.60	0.96
18030	0.94	0.03	0.71	0.88	0.92	-0.03	0.96	0.57	0.83	14.69	0.89	-0.57	0.95	0.79	1.74	20.33	0.52	0.79
18031	0.86	0.64	1.16	15.35	0.77	-0.64	0.89	1.04	1.32	24.93	0.70	-1.04	0.92	1.34	2.20	32.30	0.16	1.34
18032	0.97	1.20	1.29	29.85	0.58	-1.20	0.97	0.87	0.93	21.67	0.78	-0.87	0.95	1.00	1.31	24.92	0.56	1.00
18034	0.95	0.08	0.61	2.29	0.94	0.08	0.96	0.47	0.74	13.01	0.90	-0.47	0.94	0.67	1.66	18.47	0.51	0.67
18035	0.95	0.34	0.59	10.01	0.92	0.34	0.97	0.24	0.43	7.15	0.96	-0.24	0.93	0.13	0.94	4.01	0.80	0.13
18038	0.93	0.51	0.91	13.70	0.84	-0.51	0.95	0.57	0.81	15.33	0.88	-0.57	0.94	0.62	1.38	16.52	0.64	0.62
18049	0.76	0.18	1.26	4.88	0.75	0.18	0.77	0.47	1.31	12.75	0.73	-0.47	0.83	0.68	2.58	18.22	-0.05	0.68
18050	0.93	1.06	1.25	23.76	0.68	-1.06	0.93	1.18	1.32	26.32	0.65	-1.18	0.94	1.37	1.95	30.74	0.22	1.37
18441	0.99	0.78	0.85	24.57	0.81	0.78	0.98	0.00	0.29	0.05	0.98	0.00	0.90	0.16	0.80	5.08	0.83	-0.16
18443	0.93	0.93	1.32	21.96	0.73	-0.93	0.95	1.13	1.36	26.73	0.71	-1.13	0.96	1.43	2.26	33.70	0.21	1.43
18444	0.96	0.44	0.61	12.25	0.89	-0.44	0.98	0.44	0.53	12.34	0.92	-0.44	0.95	0.30	0.58	8.31	0.90	0.30
18445	0.86	0.74	1.21	22.84	0.68	-0.74	0.83	0.56	1.07	17.23	0.75	-0.56	0.94	0.64	1.40	19.85	0.57	0.64
18446	0.96	0.51	0.80	12.80	0.89	-0.51	0.97	0.74	0.90	18.61	0.86	-0.74	0.95	0.92	1.59	22.99	0.55	0.92
18447	0.97	0.42	0.55	12.57	0.93	0.42	0.96	0.24	0.48	7.15	0.95	-0.24	0.90	0.35	1.32	10.44	0.61	0.35
18448	0.95	1.15	1.40	27.47	0.65	-1.15	0.96	1.12	1.26	26.91	0.72	-1.12	0.97	1.36	1.95	32.69	0.32	1.36
18450	0.96	0.98	1.15	24.72	0.71	-0.98	0.97	0.88	0.97	22.20	0.80	-0.88	0.95	1.09	1.56	27.55	0.47	1.09
18901	0.95	0.81	1.13	22.59	0.74	-0.81	0.95	0.74	0.97	20.48	0.81	-0.74	0.95	0.86	1.49	23.93	0.55	0.86

Calibration with monthly K coefficients (LR)

	Hargraves and Samani						Priestley and Taylor						Mahringer					
Station	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE

9020	0.94	0.06	0.61	1.65	0.91	0.06	0.94	0.29	0.59	7.44	0.92	-0.29	0.91	0.23	0.76	5.97	0.86	0.23
17180	0.96	0.02	0.35	0.55	0.96	0.02	0.97	0.46	0.67	14.11	0.87	0.46	0.89	0.60	0.90	18.16	0.76	-0.60
17218	0.97	0.30	0.55	7.22	0.95	-0.30	0.97	0.57	0.80	13.67	0.89	-0.57	0.98	0.65	0.96	15.48	0.84	0.65
17219	0.91	0.41	1.13	9.44	0.85	-0.41	0.90	0.56	1.28	13.02	0.81	-0.56	0.98	0.67	1.43	15.58	0.76	0.67
17220	0.98	0.62	0.75	15.07	0.89	-0.62	0.97	0.31	0.47	7.50	0.95	-0.31	0.97	0.42	0.67	10.15	0.91	0.42
17221	0.95	0.03	0.38	0.98	0.95	-0.03	0.96	0.43	0.68	12.96	0.84	0.43	0.82	0.63	0.98	18.67	0.66	-0.63
17383	0.97	1.11	1.27	29.45	0.52	-1.11	0.97	0.04	0.40	1.01	0.95	0.04	0.95	0.04	0.41	1.07	0.95	0.04
17384	0.94	1.43	1.61	35.04	0.30	-1.43	0.96	0.32	0.50	7.69	0.93	-0.32	0.96	0.39	0.56	9.61	0.92	0.39
17439	0.87	1.05	1.33	27.73	0.49	-1.05	0.85	0.07	0.76	1.74	0.83	0.07	0.90	0.11	0.65	2.97	0.88	0.11
17440	0.91	0.77	1.09	19.49	0.73	-0.77	0.97	0.15	0.38	3.68	0.97	-0.15	0.98	0.24	0.43	6.21	0.96	0.24
17441	0.92	0.57	0.81	15.31	0.81	-0.57	0.97	0.02	0.35	0.55	0.96	0.02	0.96	0.03	0.36	0.88	0.96	0.03
17442	0.93	0.98	1.28	23.86	0.67	-0.98	0.96	0.26	0.52	6.30	0.94	-0.26	0.97	0.36	0.62	8.85	0.92	0.36
17443	0.49	0.26	1.08	9.53	0.42	-0.26	0.65	1.21	1.68	43.57	-0.41	1.21	0.60	0.73	1.23	26.39	0.25	-0.73
17444	0.89	0.69	1.07	18.28	0.73	-0.69	0.91	0.19	0.63	4.97	0.90	0.19	0.94	0.04	0.55	0.97	0.93	-0.04
17742	0.98	0.10	0.37	2.51	0.97	-0.10	0.97	0.30	0.55	7.79	0.94	-0.30	0.98	0.30	0.61	7.94	0.93	0.30
17749	0.98	0.28	0.43	7.57	0.97	0.28	0.98	0.16	0.51	4.46	0.95	-0.16	0.99	0.27	0.65	7.27	0.93	0.27
17782	0.96	1.45	1.63	31.86	0.50	-1.45	0.95	0.87	1.04	19.16	0.80	-0.87	0.98	0.87	1.05	19.02	0.79	0.87
17787	0.98	0.38	0.51	9.73	0.94	-0.38	0.98	0.22	0.40	5.56	0.97	-0.22	0.98	0.26	0.49	6.83	0.95	0.26
17789	0.96	0.12	0.46	3.18	0.95	0.12	0.96	0.18	0.43	4.91	0.95	-0.18	0.95	0.26	0.60	6.95	0.91	0.26
17790	0.95	0.24	0.54	6.63	0.94	0.24	0.96	0.00	0.43	0.04	0.96	0.00	0.95	0.02	0.61	0.52	0.92	0.02
17822	0.98	0.95	1.07	28.38	0.74	0.95	0.98	0.31	0.43	9.33	0.96	0.31	0.97	0.27	0.50	8.04	0.95	-0.27
17854	0.97	0.75	0.95	22.64	0.72	0.75	0.97	0.28	0.47	8.33	0.93	0.28	0.93	0.29	0.56	8.70	0.90	-0.29
18028	0.97	0.95	1.10	23.30	0.72	-0.95	0.98	0.28	0.42	6.73	0.96	-0.28	0.97	0.38	0.55	9.39	0.93	0.38
18030	0.98	0.38	0.54	9.79	0.95	0.38	0.98	0.03	0.47	0.72	0.96	0.03	0.99	0.19	0.67	4.97	0.93	0.19
18031	0.91	0.26	0.81	6.29	0.89	-0.26	0.91	0.48	0.90	11.54	0.86	-0.48	0.96	0.68	1.12	16.28	0.78	0.68
18032	0.97	0.89	0.95	22.16	0.77	-0.89	0.98	0.30	0.41	7.48	0.96	-0.30	0.97	0.45	0.61	11.14	0.90	0.45
18034	0.99	0.49	0.57	13.43	0.94	0.49	0.99	0.10	0.45	2.80	0.97	0.10	0.98	0.10	0.64	2.78	0.93	0.10
18035	0.98	0.74	0.85	22.00	0.83	0.74	0.99	0.33	0.42	9.80	0.96	0.33	0.98	0.31	0.45	9.19	0.95	-0.31
18038	0.97	0.17	0.48	4.41	0.96	-0.17	0.97	0.00	0.43	0.09	0.96	0.00	0.98	0.07	0.48	1.75	0.96	0.07
18049	0.79	0.61	1.34	16.51	0.72	0.61	0.79	0.13	1.17	3.41	0.79	0.13	0.87	0.08	1.52	2.08	0.64	0.08
18050	0.97	0.69	0.80	15.39	0.87	-0.69	0.96	0.58	0.73	12.88	0.89	-0.58	0.98	0.66	0.86	14.83	0.85	0.66
18441	0.99	1.22	1.36	38.53	0.52	1.22	0.98	0.58	0.65	18.47	0.89	0.58	0.94	0.54	0.72	17.08	0.87	-0.54
18443	0.97	0.57	0.83	13.36	0.89	-0.57	0.97	0.56	0.84	13.26	0.89	-0.56	0.99	0.71	1.06	16.79	0.83	0.71
18444	0.98	0.10	0.27	2.65	0.98	-0.10	0.98	0.14	0.35	3.91	0.96	0.14	0.96	0.14	0.41	3.80	0.95	-0.14
18445	0.89	0.46	0.92	14.12	0.82	-0.46	0.85	0.05	0.84	1.64	0.84	-0.05	0.94	0.13	0.73	4.05	0.88	0.13
18446	0.98	0.12	0.41	3.04	0.97	-0.12	0.97	0.14	0.48	3.59	0.96	-0.14	0.98	0.33	0.66	8.31	0.92	0.33
18447	0.99	0.84	0.92	25.24	0.81	0.84	0.98	0.33	0.45	10.09	0.96	0.33	0.95	0.15	0.62	4.63	0.91	-0.15
18448	0.98	0.81	0.98	19.42	0.83	-0.81	0.98	0.56	0.74	13.42	0.90	-0.56	0.98	0.70	0.96	16.84	0.84	0.70
18450	0.98	0.65	0.75	16.36	0.88	-0.65	0.98	0.31	0.44	7.86	0.96	-0.31	0.98	0.49	0.69	12.49	0.90	0.49
18901	0.98	0.50	0.73	14.01	0.89	-0.50	0.97	0.22	0.57	6.18	0.94	-0.22	0.98	0.31	0.60	8.57	0.93	0.31

Calibration with constant K coefficients (LR)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.07	0.68	1.78	0.88	0.07	0.92	0.28	0.76	7.03	0.86	-0.28	0.88	0.21	0.96	5.38	0.77	0.21
17180	0.96	0.02	0.37	0.49	0.96	0.02	0.96	0.48	0.91	14.46	0.76	0.48	0.86	0.61	0.93	18.58	0.74	-0.61
17218	0.93	0.30	0.70	7.15	0.91	-0.30	0.94	0.57	0.82	13.65	0.88	-0.57	0.95	0.65	1.32	15.66	0.69	0.65
17219	0.85	0.41	1.32	9.36	0.80	-0.41	0.86	0.56	1.26	12.97	0.81	-0.56	0.95	0.76	1.98	17.64	0.54	0.76

17220	0.96	0.61	0.82	15.00	0.86	-0.61	0.96	0.30	0.61	7.39	0.92	-0.30	0.94	0.40	0.94	9.71	0.82	0.40
17221	0.93	0.03	0.46	0.87	0.93	-0.03	0.96	0.43	0.92	12.71	0.70	0.43	0.79	0.65	1.01	19.35	0.64	-0.65
17383	0.94	1.12	1.31	29.51	0.49	-1.12	0.96	0.02	0.69	0.43	0.86	0.02	0.93	0.01	0.52	0.35	0.92	0.01
17384	0.89	1.44	1.66	35.18	0.25	-1.44	0.94	0.35	0.75	8.52	0.85	-0.35	0.94	0.39	0.77	9.62	0.84	0.39
17439	0.83	1.05	1.38	27.77	0.45	-1.05	0.84	0.05	0.95	1.22	0.74	0.05	0.90	0.10	0.78	2.74	0.83	0.10
17440	0.83	0.76	1.20	19.31	0.67	-0.76	0.95	0.18	0.59	4.45	0.92	-0.18	0.94	0.26	0.79	6.56	0.86	0.26
17441	0.88	0.56	0.88	15.21	0.77	-0.56	0.96	0.01	0.62	0.21	0.89	-0.01	0.93	0.01	0.51	0.19	0.93	0.01
17442	0.88	0.98	1.35	23.80	0.63	-0.98	0.94	0.27	0.66	6.67	0.91	-0.27	0.94	0.35	0.91	8.62	0.83	0.35
17443	0.47	0.26	1.09	9.45	0.41	-0.26	0.65	1.16	1.86	41.95	-0.73	1.16	0.61	0.74	1.26	26.67	0.21	-0.74
17444	0.84	0.69	1.15	18.26	0.69	-0.69	0.91	0.17	0.76	4.51	0.86	0.17	0.92	0.04	0.75	0.95	0.87	-0.04
17742	0.95	0.09	0.55	2.44	0.94	-0.09	0.95	0.29	0.59	7.64	0.93	-0.29	0.95	0.32	0.96	8.32	0.83	0.32
17749	0.94	0.28	0.63	7.60	0.93	0.28	0.96	0.18	0.51	4.81	0.95	-0.18	0.95	0.30	1.07	8.08	0.80	0.30
17782	0.91	1.45	1.70	31.91	0.45	-1.45	0.91	0.89	1.13	19.59	0.76	-0.89	0.95	0.88	1.38	19.42	0.64	0.88
17787	0.95	0.38	0.65	9.70	0.91	-0.38	0.96	0.22	0.56	5.66	0.93	-0.22	0.94	0.26	0.83	6.81	0.85	0.26
17789	0.94	0.12	0.56	3.22	0.92	0.12	0.95	0.19	0.57	5.06	0.92	-0.19	0.92	0.25	0.86	6.63	0.82	0.25
17790	0.92	0.25	0.67	6.71	0.90	0.25	0.94	0.00	0.61	0.11	0.92	0.00	0.91	0.05	0.93	1.27	0.81	0.05
17822	0.98	0.94	1.05	28.21	0.75	0.94	0.98	0.30	0.52	9.06	0.94	0.30	0.93	0.26	0.72	7.82	0.88	-0.26
17854	0.97	0.75	0.91	22.54	0.74	0.75	0.97	0.27	0.64	8.06	0.87	0.27	0.90	0.31	0.66	9.48	0.86	-0.31
18028	0.92	0.94	1.17	22.98	0.68	-0.94	0.96	0.29	0.60	7.05	0.92	-0.29	0.95	0.34	0.71	8.24	0.88	0.34
18030	0.94	0.39	0.75	10.12	0.91	0.39	0.96	0.02	0.48	0.57	0.96	0.02	0.95	0.22	1.15	5.56	0.79	0.22
18031	0.86	0.25	0.94	5.96	0.85	-0.25	0.89	0.48	0.94	11.50	0.85	-0.48	0.92	0.67	1.47	16.07	0.62	0.67
18032	0.97	0.89	0.96	22.06	0.76	-0.89	0.97	0.31	0.57	7.66	0.92	-0.31	0.95	0.39	0.71	9.59	0.87	0.39
18034	0.95	0.50	0.73	13.64	0.91	0.50	0.96	0.09	0.47	2.54	0.96	0.09	0.94	0.14	1.12	3.93	0.78	0.14
18035	0.95	0.74	0.93	22.22	0.80	0.74	0.97	0.32	0.53	9.46	0.94	0.32	0.93	0.29	0.75	8.76	0.87	-0.29
18038	0.93	0.15	0.67	4.12	0.91	-0.15	0.95	0.01	0.53	0.19	0.95	-0.01	0.94	0.08	0.90	2.22	0.85	0.08
18049	0.76	0.61	1.41	16.52	0.69	0.61	0.77	0.11	1.25	2.86	0.75	0.11	0.83	0.14	2.00	3.71	0.37	0.14
18050	0.93	0.68	0.91	15.30	0.83	-0.68	0.93	0.59	0.88	13.14	0.84	-0.59	0.94	0.66	1.22	14.70	0.70	0.66
18441	0.99	1.21	1.33	38.40	0.54	1.21	0.98	0.57	0.77	17.95	0.85	0.57	0.90	0.53	0.84	16.73	0.82	-0.53
18443	0.93	0.56	0.99	13.30	0.85	-0.56	0.95	0.58	0.84	13.63	0.89	-0.58	0.96	0.73	1.47	17.29	0.66	0.73
18444	0.96	0.09	0.39	2.52	0.96	-0.09	0.98	0.12	0.59	3.34	0.90	0.12	0.95	0.18	0.46	4.99	0.94	-0.18
18445	0.86	0.46	0.99	14.28	0.79	-0.46	0.83	0.08	0.90	2.43	0.82	-0.08	0.94	0.17	0.93	5.14	0.81	0.17
18446	0.96	0.12	0.51	3.12	0.95	-0.12	0.97	0.16	0.49	4.06	0.96	-0.16	0.95	0.31	0.97	7.89	0.83	0.31
18447	0.97	0.83	0.94	25.06	0.80	0.83	0.96	0.31	0.58	9.45	0.93	0.31	0.90	0.10	0.98	3.11	0.79	-0.10
18448	0.95	0.81	1.06	19.42	0.80	-0.81	0.96	0.58	0.74	13.83	0.90	-0.58	0.97	0.69	1.20	16.40	0.74	0.69
18450	0.96	0.65	0.82	16.37	0.85	-0.65	0.97	0.33	0.55	8.29	0.94	-0.33	0.95	0.47	0.92	11.89	0.82	0.47
18901	0.95	0.50	0.83	14.00	0.86	-0.50	0.95	0.23	0.55	6.26	0.94	-0.23	0.95	0.31	0.92	8.72	0.83	0.31

Calibration with monthly A and B coefficients (LR)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.93	0.09	0.57	2.36	0.92	-0.09	0.94	0.25	0.56	6.26	0.92	-0.25	0.99	0.03	0.16	0.74	0.99	0.03
17180	0.97	0.26	0.45	7.96	0.94	0.26	0.97	0.46	0.63	13.89	0.88	0.46	0.99	0.06	0.17	1.89	0.99	-0.06
17218	0.96	0.42	0.66	9.97	0.92	-0.42	0.97	0.55	0.77	13.08	0.90	-0.55	1.00	0.05	0.15	1.11	1.00	0.05
17219	0.91	0.54	1.25	12.51	0.82	-0.54	0.91	0.58	1.28	13.46	0.81	-0.58	1.00	0.04	0.13	0.96	1.00	-0.04
17220	0.97	0.47	0.62	11.53	0.92	-0.47	0.98	0.33	0.49	8.06	0.95	-0.33	1.00	0.01	0.10	0.30	1.00	-0.01
17221	0.96	0.21	0.48	6.37	0.92	0.21	0.97	0.40	0.64	11.89	0.85	0.40	0.99	0.09	0.18	2.58	0.99	-0.09
17383	0.97	0.45	0.55	12.00	0.91	-0.45	0.97	0.02	0.38	0.60	0.96	-0.02	1.00	0.00	0.11	0.10	1.00	0.00
17384	0.97	0.76	0.85	18.66	0.81	-0.76	0.97	0.37	0.52	8.95	0.93	-0.37	1.00	0.01	0.13	0.27	1.00	0.01

17439	0.90	0.40	0.71	10.60	0.86	-0.40	0.88	0.01	0.71	0.23	0.86	0.01	1.00	0.06	0.16	1.64	0.99	0.06
17440	0. 97	0.42	0.58	10.74	0.92	-0.42	0.98	0.20	0.38	5.18	0.97	-0.20	1.00	0.00	0.10	0.07	1.00	0.00
17441	0.97	0.23	0.40	6.23	0.95	-0.23	0.98	0.02	0.34	0.55	0.97	-0.02	1.00	0.01	0.10	0.32	1.00	0.01
17442	0.96	0.63	0.81	15.31	0.87	-0.63	0.97	0.33	0.53	7.92	0.94	-0.33	1.00	0.05	0.11	1.32	1.00	-0.05
17443	0.68	0.48	1.11	17.42	0.39	0.48	0.68	1.07	1.59	38.64	-0.26	1.07	0.97	0.17	0.33	6.05	0.95	0.17
17444	0.94	0.22	0.57	5.86	0.92	-0.22	0.93	0.11	0.56	2.89	0.93	0.11	1.00	0.01	0.12	0.23	1.00	-0.01
17742	0.98	0.10	0.41	2.63	0.97	-0.10	0.98	0.23	0.50	6.09	0.95	-0.23	1.00	0.06	0.11	1.66	1.00	0.06
17749	0.98	0.09	0.45	2.35	0.97	0.09	0.98	0.13	0.49	3.51	0.96	-0.13	1.00	0.08	0.15	2.08	1.00	0.08
17782	0.96	1.09	1.22	23.96	0.72	-1.09	0.96	0.89	1.04	19.52	0.79	-0.89	1.00	0.02	0.13	0.46	1.00	-0.02
17787	0.98	0.26	0.40	6.62	0.97	-0.26	0.98	0.21	0.38	5.40	0.97	-0.21	1.00	0.03	0.07	0.69	1.00	0.03
17789	0.96	0.02	0.42	0.40	0.96	0.02	0.97	0.15	0.37	4.07	0.97	-0.15	0.98	0.10	0.30	2.57	0.98	0.10
17790	0.96	0.11	0.46	2.95	0.96	0.11	0.96	0.02	0.42	0.43	0.96	0.02	1.00	0.02	0.15	0.48	1.00	0.02
17822	0.98	0.53	0.61	15.96	0.92	0.53	0.98	0.31	0.42	9.19	0.96	0.31	1.00	0.02	0.10	0.51	1.00	0.02
17854	0.97	0.49	0.66	14.74	0.86	0.49	0.97	0.30	0.49	9.01	0.93	0.30	0.99	0.06	0.16	1.86	0.99	0.06
18028	0.98	0.60	0.69	14.54	0.89	-0.60	0.98	0.34	0.45	8.25	0.95	-0.34	1.00	0.02	0.10	0.60	1.00	-0.02
18030	0.98	0.00	0.50	0.08	0.96	0.00	0.98	0.06	0.49	1.58	0.96	-0.06	1.00	0.07	0.10	1.75	1.00	-0.07
18031	0.93	0.40	0.81	9.55	0.89	-0.40	0.93	0.48	0.84	11.55	0.88	-0.48	0.98	0.05	0.33	1.29	0.98	0.05
18032	0.98	0.53	0.62	13.27	0.90	-0.53	0.98	0.33	0.42	8.08	0.96	-0.33	1.00	0.05	0.09	1.11	1.00	0.05
18034	0.98	0.20	0.44	5.43	0.97	0.20	0.99	0.07	0.42	1.84	0.97	0.07	1.00	0.03	0.10	0.79	1.00	0.03
18035	0.98	0.47	0.54	14.11	0.93	0.47	0.99	0.31	0.38	9.29	0.97	0.31	1.00	0.00	0.08	0.11	1.00	0.00
18038	0.98	0.09	0.43	2.47	0.96	-0.09	0.98	0.03	0.41	0.78	0.97	-0.03	1.00	0.03	0.08	0.66	1.00	-0.03
18049	0.78	0.15	1.19	4.00	0.78	0.15	0.78	0.04	1.18	1.13	0.78	0.04	0.95	0.00	0.64	0.02	0.94	0.00
18050	0.97	0.77	0.87	17.14	0.85	-0.77	0.96	0.66	0.79	14.78	0.87	-0.66	1.00	0.07	0.11	1.60	1.00	-0.07
18441	0.99	0.74	0.81	23.48	0.83	0.74	0.98	0.55	0.61	17.25	0.90	0.55	1.00	0.02	0.11	0.52	1.00	-0.02
18443	0.97	0.58	0.86	13.71	0.89	-0.58	0.97	0.58	0.85	13.65	0.89	-0.58	1.00	0.00	0.08	0.02	1.00	0.00
18444	0.98	0.02	0.30	0.47	0.97	0.02	0.98	0.11	0.34	3.06	0.97	0.11	1.00	0.02	0.07	0.52	1.00	-0.02
18445	0.87	0.11	0.78	3.53	0.87	0.11	0.87	0.07	0.80	2.26	0.86	0.07	0.99	0.27	0.36	8.32	0.97	0.27
18446	0.98	0.27	0.51	6.80	0.95	-0.27	0.98	0.21	0.49	5.33	0.96	-0.21	1.00	0.05	0.11	1.33	1.00	-0.05
18447	0.98	0.50	0.57	14.97	0.93	0.50	0.98	0.32	0.43	9.59	0.96	0.32	1.00	0.07	0.19	2.25	0.99	0.07
18448	0.98	0.63	0.80	15.02	0.89	-0.63	0.98	0.56	0.73	13.36	0.91	-0.56	1.00	0.04	0.10	0.89	1.00	0.04
18450	0.98	0.42	0.55	10.65	0.94	-0.42	0.98	0.31	0.44	7.96	0.96	-0.31	1.00	0.07	0.11	1.80	1.00	0.07
18901	0.98	0.10	0.44	2.73	0.96	-0.10	0.98	0.12	0.47	3.43	0.96	-0.12	1.00	0.17	0.21	4.84	0.99	0.17

Station	Calibration with constanr A and B coefficients (LR)																	
	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.04	0.61	1.11	0.91	0.04	0.92	0.27	0.63	6.78	0.90	-0.27	0.88	0.07	0.72	1.80	0.87	0.07
17180	0.96	0.05	0.44	1.62	0.94	0.05	0.96	0.47	0.66	14.16	0.87	0.47	0.86	0.27	0.97	8.24	0.72	-0.27
17218	0.93	0.31	0.77	7.53	0.90	-0.31	0.94	0.55	0.88	13.29	0.86	-0.55	0.95	0.28	0.62	6.70	0.93	0.28
17219	0.85	0.43	1.42	9.89	0.76	-0.43	0.86	0.57	1.40	13.16	0.77	-0.57	0.95	0.30	0.75	7.06	0.94	0.30
17220	0.96	0.59	0.88	14.49	0.84	-0.59	0.96	0.32	0.56	7.72	0.94	-0.32	0.94	0.14	0.64	3.32	0.92	0.14
17221	0.93	0.01	0.47	0.18	0.92	0.01	0.96	0.41	0.66	12.36	0.85	0.41	0.79	0.32	1.00	9.46	0.64	-0.32
17383	0.94	1.02	1.29	26.97	0.51	-1.02	0.96	0.00	0.44	0.02	0.94	0.00	0.93	0.02	0.68	0.51	0.86	-0.02
17384	0.89	1.34	1.62	32.80	0.29	-1.34	0.94	0.36	0.61	8.69	0.90	-0.36	0.94	0.13	0.59	3.22	0.91	0.13
17439	0.83	0.97	1.36	25.42	0.47	-0.97	0.84	0.02	0.78	0.64	0.83	0.02	0.90	0.04	0.66	0.98	0.88	0.04
17440	0.83	0.71	1.22	18.07	0.66	-0.71	0.95	0.18	0.52	4.69	0.94	-0.18	0.94	0.09	0.59	2.38	0.92	0.09
17441	0.88	0.51	0.89	13.79	0.76	-0.51	0.96	0.01	0.40	0.18	0.95	-0.01	0.93	0.01	0.67	0.14	0.87	0.01
17442	0.88	0.92	1.38	22.51	0.61	-0.92	0.94	0.30	0.62	7.18	0.92	-0.30	0.94	0.10	0.61	2.45	0.92	0.10
17443	0.47	0.15	1.05	5.46	0.45	-0.15	0.65	1.13	1.63	40.65	-0.33	1.13	0.61	0.19	0.91	6.73	0.59	-0.19

17444	0.84	0.63	1.17	16.74	0.67	-0.63	0.91	0.13	0.65	3.52	0.90	0.13	0.92	0.05	0.68	1.30	0.89	-0.05
17742	0.95	0.09	0.62	2.46	0.93	-0.09	0.95	0.26	0.64	6.86	0.92	-0.26	0.95	0.18	0.60	4.71	0.93	0.18
17749	0.94	0.26	0.67	6.95	0.92	0.26	0.96	0.15	0.63	3.98	0.93	-0.15	0.95	0.21	0.59	5.61	0.94	0.21
17782	0.91	1.40	1.71	30.69	0.44	-1.40	0.91	0.89	1.14	19.46	0.75	-0.89	0.95	0.31	0.61	6.73	0.93	0.31
17787	0.95	0.36	0.71	9.20	0.89	-0.36	0.96	0.21	0.49	5.46	0.95	-0.21	0.94	0.12	0.63	3.10	0.91	0.12
17789	0.94	0.11	0.52	2.81	0.93	0.11	0.95	0.17	0.47	4.45	0.95	-0.17	0.92	0.15	0.65	4.07	0.90	0.15
17790	0.92	0.23	0.66	6.19	0.91	0.23	0.94	0.01	0.53	0.26	0.94	0.01	0.91	0.04	0.70	1.21	0.89	0.04
17822	0.98	0.89	0.95	26.56	0.80	0.89	0.98	0.31	0.46	9.28	0.95	0.31	0.93	0.06	0.69	1.73	0.89	-0.06
17854	0.97	0.71	0.80	21.53	0.80	0.71	0.97	0.29	0.45	8.59	0.94	0.29	0.90	0.08	0.76	2.52	0.82	-0.08
18028	0.92	0.89	1.19	21.75	0.67	-0.89	0.96	0.31	0.51	7.45	0.94	-0.31	0.95	0.09	0.59	2.29	0.92	0.09
18030	0.94	0.34	0.78	8.71	0.90	0.34	0.96	0.01	0.60	0.28	0.94	-0.01	0.95	0.08	0.61	2.06	0.94	0.08
18031	0.86	0.27	1.00	6.43	0.83	-0.27	0.89	0.47	0.95	11.42	0.85	-0.47	0.92	0.29	0.72	7.09	0.91	0.29
18032	0.97	0.84	0.95	20.76	0.77	-0.84	0.97	0.31	0.44	7.72	0.95	-0.31	0.95	0.15	0.59	3.72	0.91	0.15
18034	0.95	0.46	0.75	12.55	0.90	0.46	0.96	0.09	0.57	2.44	0.94	0.09	0.94	0.12	0.61	3.25	0.93	0.12
18035	0.95	0.71	0.86	21.14	0.83	0.71	0.97	0.32	0.48	9.64	0.95	0.32	0.93	0.08	0.69	2.33	0.89	-0.08
18038	0.93	0.14	0.76	3.84	0.89	-0.14	0.95	0.01	0.57	0.34	0.94	-0.01	0.94	0.04	0.65	1.10	0.92	0.04
18049	0.76	0.56	1.36	14.93	0.71	0.56	0.77	0.09	1.22	2.34	0.77	0.09	0.83	0.09	1.10	2.30	0.81	0.09
18050	0.93	0.69	0.95	15.48	0.81	-0.69	0.93	0.62	0.86	13.77	0.85	-0.62	0.94	0.18	0.61	4.09	0.93	0.18
18441	0.99	1.15	1.20	36.40	0.62	1.15	0.98	0.56	0.63	17.79	0.90	0.56	0.90	0.18	0.81	5.55	0.83	-0.18
18443	0.93	0.56	1.08	13.25	0.82	-0.56	0.95	0.57	0.95	13.50	0.86	-0.57	0.96	0.31	0.61	7.29	0.94	0.31
18444	0.96	0.07	0.43	1.96	0.95	-0.07	0.98	0.12	0.31	3.36	0.97	0.12	0.95	0.08	0.74	2.17	0.84	-0.08
18445	0.86	0.38	1.02	11.60	0.77	-0.38	0.83	0.01	0.92	0.16	0.82	0.01	0.94	0.27	0.64	8.24	0.91	0.27
18446	0.96	0.14	0.62	3.50	0.93	-0.14	0.97	0.18	0.55	4.53	0.95	-0.18	0.95	0.12	0.59	2.88	0.94	0.12
18447	0.97	0.79	0.87	23.81	0.83	0.79	0.96	0.32	0.53	9.78	0.94	0.32	0.90	0.06	0.70	1.78	0.89	0.06
18448	0.95	0.78	1.12	18.68	0.78	-0.78	0.96	0.56	0.81	13.47	0.88	-0.56	0.97	0.30	0.56	7.16	0.94	0.30
18450	0.96	0.61	0.86	15.44	0.84	-0.61	0.97	0.32	0.51	7.99	0.94	-0.32	0.95	0.23	0.59	5.82	0.92	0.23
18901	0.95	0.45	0.90	12.44	0.84	-0.45	0.95	0.18	0.65	4.89	0.92	-0.18	0.95	0.24	0.59	6.73	0.93	0.24

Calibration with monthly K coefficients (GD)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.94	0.05	0.59	1.29	0.91	-0.05	0.94	0.33	0.61	8.35	0.91	-0.33	0.91	0.25	0.66	6.48	0.89	-0.25
17180	0.97	0.08	0.36	2.43	0.96	-0.08	0.97	0.43	0.65	12.98	0.87	0.43	0.89	0.91	1.17	27.78	0.60	-0.91
17218	0.96	0.41	0.63	9.92	0.93	-0.41	0.97	0.61	0.82	14.56	0.88	-0.61	0.98	0.09	0.48	2.05	0.96	0.09
17219	0.91	0.53	1.20	12.07	0.83	-0.53	0.90	0.60	1.29	13.91	0.80	-0.60	0.97	0.10	0.91	2.40	0.90	0.10
17220	0.98	0.72	0.84	17.57	0.86	-0.72	0.97	0.35	0.50	8.44	0.95	-0.35	0.97	0.11	0.40	2.76	0.97	-0.11
17221	0.95	0.13	0.39	3.94	0.95	-0.13	0.96	0.39	0.66	11.78	0.85	0.39	0.83	0.95	1.24	28.29	0.45	-0.95
17383	0.97	1.20	1.35	31.60	0.46	-1.20	0.97	0.00	0.41	0.07	0.95	0.00	0.96	0.41	0.60	10.85	0.89	-0.41
17384	0.94	1.51	1.69	37.01	0.23	-1.51	0.96	0.36	0.53	8.70	0.92	-0.36	0.97	0.13	0.37	3.25	0.96	-0.13
17439	0.87	1.14	1.40	29.92	0.43	-1.14	0.85	0.03	0.76	0.65	0.83	0.03	0.91	0.35	0.66	9.12	0.88	-0.35
17440	0.91	0.86	1.16	21.92	0.69	-0.86	0.97	0.19	0.40	4.73	0.96	-0.19	0.98	0.24	0.37	6.16	0.97	-0.24
17441	0.92	0.66	0.88	17.89	0.77	-0.66	0.97	0.02	0.36	0.55	0.96	-0.02	0.97	0.41	0.57	11.03	0.91	-0.41
17442	0.93	1.07	1.36	26.16	0.62	-1.07	0.96	0.30	0.54	7.29	0.94	-0.30	0.97	0.16	0.40	3.89	0.97	-0.16
17443	0.49	0.34	1.09	12.31	0.41	-0.34	0.65	1.16	1.66	41.93	-0.37	1.16	0.61	0.97	1.34	35.08	0.11	-0.97
17444	0.89	0.78	1.14	20.70	0.69	-0.78	0.91	0.15	0.62	3.86	0.91	0.15	0.94	0.47	0.68	12.51	0.89	-0.47
17742	0.98	0.20	0.42	5.34	0.97	-0.20	0.97	0.33	0.56	8.72	0.94	-0.33	0.98	0.17	0.38	4.57	0.97	-0.17
17749	0.98	0.16	0.37	4.41	0.98	0.16	0.98	0.20	0.52	5.47	0.95	-0.20	0.98	0.19	0.42	5.12	0.97	-0.19
17782	0.96	1.54	1.72	33.90	0.44	-1.54	0.95	0.91	1.07	20.03	0.78	-0.91	0.98	0.23	0.44	5.13	0.96	0.23
17787	0.98	0.48	0.60	12.39	0.92	-0.48	0.98	0.25	0.42	6.53	0.96	-0.25	0.98	0.22	0.39	5.65	0.97	-0.22

17789	0.96	0.01	0.43	0.17	0.95	0.01	0.96	0.22	0.45	5.90	0.95	-0.22	0.95	0.21	0.49	5.57	0.94	-0.21
17790	0.95	0.13	0.49	3.51	0.95	0.13	0.96	0.04	0.43	1.04	0.96	-0.04	0.95	0.41	0.65	11.09	0.91	-0.41
17822	0.98	0.82	0.95	24.63	0.80	0.82	0.98	0.27	0.40	8.19	0.96	0.27	0.97	0.63	0.74	18.69	0.88	-0.63
17854	0.97	0.63	0.84	19.01	0.78	0.63	0.97	0.24	0.45	7.20	0.94	0.24	0.93	0.65	0.83	19.45	0.78	-0.65
18028	0.96	1.05	1.19	25.57	0.67	-1.05	0.98	0.32	0.45	7.73	0.95	-0.32	0.98	0.15	0.34	3.55	0.97	-0.15
18030	0.98	0.26	0.47	6.57	0.97	0.26	0.98	0.01	0.46	0.34	0.97	-0.01	0.98	0.28	0.50	7.15	0.96	-0.28
18031	0.91	0.38	0.86	9.06	0.87	-0.38	0.91	0.52	0.91	12.45	0.86	-0.52	0.96	0.11	0.66	2.69	0.92	0.11
18032	0.98	0.98	1.04	24.42	0.73	-0.98	0.98	0.34	0.44	8.46	0.95	-0.34	0.98	0.08	0.32	2.05	0.97	-0.08
18034	0.98	0.37	0.48	10.11	0.96	0.37	0.98	0.06	0.43	1.71	0.97	0.06	0.98	0.33	0.54	9.01	0.95	-0.33
18035	0.98	0.62	0.74	18.43	0.88	0.62	0.99	0.29	0.38	8.64	0.97	0.29	0.97	0.66	0.75	19.70	0.87	-0.66
18038	0.97	0.27	0.55	7.20	0.94	-0.27	0.97	0.04	0.43	1.14	0.97	-0.04	0.98	0.38	0.52	10.05	0.95	-0.38
18049	0.79	0.49	1.28	13.06	0.74	0.49	0.79	0.09	1.16	2.31	0.79	0.09	0.87	0.36	1.31	9.60	0.73	-0.36
18050	0.97	0.80	0.90	17.89	0.83	-0.80	0.96	0.62	0.76	13.80	0.88	-0.62	0.98	0.06	0.37	1.38	0.97	0.06
18441	0.99	1.09	1.23	34.46	0.61	1.09	0.98	0.54	0.61	17.21	0.90	0.54	0.94	0.84	0.99	26.69	0.74	-0.84
18443	0.97	0.68	0.93	15.92	0.87	-0.68	0.97	0.60	0.86	14.18	0.89	-0.60	0.99	0.14	0.51	3.24	0.96	0.14
18444	0.98	0.20	0.33	5.57	0.97	-0.20	0.98	0.10	0.34	2.80	0.97	0.10	0.97	0.54	0.71	15.20	0.85	-0.54
18445	0.89	0.54	0.97	16.64	0.79	-0.54	0.85	0.09	0.85	2.71	0.84	-0.09	0.95	0.26	0.61	7.95	0.92	-0.26
18446	0.98	0.24	0.46	5.91	0.96	-0.24	0.97	0.18	0.48	4.62	0.96	-0.18	0.98	0.17	0.40	4.36	0.97	-0.17
18447	0.99	0.71	0.79	21.55	0.86	0.71	0.98	0.30	0.42	8.91	0.96	0.30	0.95	0.52	0.72	15.54	0.88	-0.52
18448	0.98	0.91	1.08	21.80	0.79	-0.91	0.98	0.60	0.76	14.35	0.90	-0.60	0.99	0.13	0.40	3.15	0.97	0.13
18450	0.98	0.74	0.85	18.83	0.84	-0.74	0.98	0.35	0.46	8.84	0.95	-0.35	0.98	0.03	0.31	0.73	0.98	-0.03
18901	0.98	0.59	0.81	16.51	0.87	-0.59	0.97	0.26	0.57	7.14	0.93	-0.26	0.98	0.15	0.36	4.07	0.97	-0.15

Calibration with constant K coefficients (GD)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.03	0.66	0.66	0.89	-0.03	0.92	0.44	0.78	11.35	0.85	-0.44	0.88	0.37	0.83	9.48	0.83	-0.37
17180	0.96	0.06	0.39	1.91	0.96	-0.06	0.96	0.30	0.74	9.14	0.84	0.30	0.86	0.99	1.25	30.06	0.54	-0.99
17218	0.93	0.39	0.76	9.37	0.90	-0.39	0.94	0.74	0.95	17.66	0.84	-0.74	0.95	0.03	0.77	0.65	0.90	-0.03
17219	0.85	0.50	1.37	11.54	0.78	-0.50	0.86	0.73	1.38	17.02	0.78	-0.73	0.95	0.05	1.25	1.05	0.82	0.05
17220	0.96	0.70	0.90	17.04	0.84	-0.70	0.96	0.48	0.68	11.70	0.91	-0.48	0.94	0.24	0.65	5.76	0.91	-0.24
17221	0.93	0.11	0.47	3.24	0.92	-0.11	0.96	0.25	0.76	7.47	0.80	0.25	0.79	1.03	1.32	30.72	0.39	-1.03
17383	0.94	1.18	1.38	31.19	0.43	-1.18	0.96	0.16	0.62	4.24	0.89	-0.16	0.93	0.52	0.72	13.80	0.84	-0.52
17384	0.89	1.50	1.73	36.73	0.19	-1.50	0.94	0.52	0.79	12.77	0.83	-0.52	0.94	0.24	0.55	5.84	0.92	-0.24
17439	0.83	1.12	1.44	29.50	0.40	-1.12	0.84	0.13	0.89	3.48	0.77	-0.13	0.90	0.45	0.77	11.74	0.83	-0.45
17440	0.83	0.84	1.26	21.25	0.63	-0.84	0.95	0.35	0.62	8.89	0.91	-0.35	0.94	0.33	0.63	8.47	0.91	-0.33
17441	0.88	0.64	0.94	17.24	0.74	-0.64	0.96	0.18	0.57	4.85	0.91	-0.18	0.93	0.52	0.71	13.93	0.85	-0.52
17442	0.88	1.05	1.42	25.63	0.59	-1.05	0.94	0.45	0.72	11.01	0.89	-0.45	0.94	0.28	0.65	6.69	0.91	-0.28
17443	0.47	0.32	1.10	11.61	0.40	-0.32	0.65	0.98	1.68	35.36	-0.41	0.98	0.61	1.03	1.39	37.01	0.05	-1.03
17444	0.84	0.76	1.21	20.22	0.65	-0.76	0.91	0.01	0.69	0.34	0.89	-0.01	0.92	0.56	0.82	14.91	0.84	-0.56
17742	0.95	0.18	0.59	4.78	0.94	-0.18	0.95	0.45	0.68	11.93	0.91	-0.45	0.95	0.26	0.66	6.95	0.92	-0.26
17749	0.94	0.19	0.60	5.02	0.94	0.19	0.96	0.34	0.61	9.23	0.94	-0.34	0.95	0.26	0.73	7.16	0.91	-0.26
17782	0.91	1.53	1.78	33.54	0.40	-1.53	0.91	1.06	1.26	23.32	0.70	-1.06	0.95	0.12	0.71	2.58	0.90	0.12
17787	0.95	0.46	0.71	11.86	0.89	-0.46	0.96	0.39	0.60	10.04	0.92	-0.39	0.94	0.32	0.66	8.25	0.91	-0.32
17789	0.94	0.03	0.53	0.75	0.93	0.03	0.95	0.35	0.60	9.47	0.91	-0.35	0.92	0.31	0.70	8.40	0.88	-0.31
17790	0.92	0.15	0.64	4.16	0.91	0.15	0.94	0.17	0.59	4.54	0.93	-0.17	0.91	0.48	0.86	13.01	0.84	-0.48
17822	0.98	0.84	0.94	25.14	0.80	0.84	0.98	0.13	0.39	3.99	0.97	0.13	0.93	0.70	0.89	20.82	0.82	-0.70
17854	0.97	0.65	0.80	19.61	0.80	0.65	0.97	0.10	0.51	3.04	0.92	0.10	0.90	0.74	0.95	22.24	0.72	-0.74
18028	0.92	1.02	1.24	24.83	0.64	-1.02	0.96	0.47	0.66	11.37	0.90	-0.47	0.95	0.29	0.54	7.02	0.93	-0.29

18030	0.94	0.29	0.71	7.48	0.92	0.29	0.96	0.16	0.52	4.11	0.96	-0.16	0.95	0.36	0.84	9.32	0.89	-0.36
18031	0.86	0.34	0.98	8.21	0.84	-0.34	0.89	0.65	1.02	15.62	0.82	-0.65	0.92	0.01	0.93	0.30	0.85	-0.01
18032	0.97	0.96	1.04	23.93	0.73	-0.96	0.97	0.48	0.63	11.95	0.90	-0.48	0.95	0.24	0.50	5.86	0.94	-0.24
18034	0.95	0.40	0.67	10.92	0.92	0.40	0.96	0.08	0.47	2.22	0.96	-0.08	0.94	0.39	0.85	10.73	0.87	-0.39
18035	0.95	0.65	0.83	19.30	0.84	0.65	0.97	0.15	0.40	4.37	0.96	0.15	0.93	0.72	0.92	21.62	0.81	-0.72
18038	0.93	0.24	0.72	6.42	0.90	-0.24	0.95	0.18	0.55	4.83	0.94	-0.18	0.94	0.46	0.79	12.20	0.88	-0.46
18049	0.76	0.51	1.36	13.73	0.71	0.51	0.77	0.07	1.23	1.92	0.76	-0.07	0.83	0.41	1.59	10.91	0.60	-0.41
18050	0.93	0.77	0.99	17.33	0.80	-0.77	0.93	0.77	0.98	17.18	0.80	-0.77	0.94	0.07	0.71	1.48	0.90	-0.07
18441	0.99	1.11	1.21	35.08	0.62	1.11	0.98	0.39	0.58	12.47	0.91	0.39	0.90	0.90	1.10	28.47	0.69	-0.90
18443	0.93	0.65	1.06	15.37	0.83	-0.65	0.95	0.75	0.98	17.65	0.85	-0.75	0.96	0.03	0.84	0.75	0.89	0.03
18444	0.96	0.17	0.42	4.85	0.95	-0.17	0.98	0.05	0.48	1.47	0.93	-0.05	0.95	0.66	0.82	18.38	0.80	-0.66
18445	0.86	0.53	1.04	16.33	0.76	-0.53	0.83	0.23	0.92	6.96	0.82	-0.23	0.94	0.31	0.71	9.69	0.89	-0.31
18446	0.96	0.22	0.56	5.44	0.94	-0.22	0.97	0.34	0.56	8.52	0.94	-0.34	0.95	0.29	0.68	7.32	0.92	-0.29
18447	0.97	0.73	0.84	22.06	0.84	0.73	0.96	0.15	0.46	4.37	0.95	0.15	0.90	0.56	0.93	16.78	0.81	-0.56
18448	0.95	0.89	1.14	21.35	0.77	-0.89	0.96	0.75	0.88	17.84	0.86	-0.75	0.97	0.00	0.61	0.01	0.93	0.00
18450	0.96	0.73	0.90	18.37	0.83	-0.73	0.97	0.50	0.63	12.55	0.91	-0.50	0.95	0.15	0.56	3.89	0.93	-0.15
18901	0.95	0.58	0.90	16.06	0.84	-0.58	0.95	0.38	0.65	10.61	0.92	-0.38	0.95	0.24	0.62	6.61	0.92	-0.24

Calibration with monthly A and B coefficients (GD)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.94	0.06	0.57	1.45	0.92	-0.06	0.94	0.28	0.58	7.24	0.92	-0.28	0.99	0.00	0.18	0.02	0.99	0.00
17180	0.97	0.07	0.34	1.99	0.97	0.07	0.97	0.45	0.65	13.74	0.88	0.45	0.99	0.15	0.27	4.67	0.98	-0.15
17218	0.97	0.40	0.62	9.65	0.93	-0.40	0.97	0.57	0.79	13.69	0.89	-0.57	1.00	0.06	0.16	1.43	1.00	0.06
17219	0.91	0.52	1.21	11.99	0.83	-0.52	0.90	0.58	1.28	13.44	0.81	-0.58	1.00	0.01	0.12	0.13	1.00	-0.01
17220	0.98	0.61	0.74	14.95	0.89	-0.61	0.97	0.33	0.49	8.03	0.95	-0.33	1.00	0.02	0.12	0.47	1.00	-0.02
17221	0.96	0.01	0.35	0.31	0.96	0.01	0.96	0.40	0.65	12.08	0.85	0.40	0.99	0.18	0.29	5.45	0.97	-0.18
17383	0.98	0.90	1.01	23.75	0.70	-0.90	0.97	0.00	0.39	0.10	0.95	0.00	1.00	0.05	0.13	1.33	1.00	-0.05
17384	0.95	1.21	1.35	29.64	0.51	-1.21	0.96	0.35	0.52	8.65	0.93	-0.35	1.00	0.01	0.12	0.17	1.00	-0.01
17439	0.89	0.84	1.09	22.16	0.66	-0.84	0.86	0.02	0.74	0.63	0.84	0.02	1.00	0.02	0.13	0.43	1.00	0.02
17440	0.94	0.69	0.94	17.44	0.80	-0.69	0.98	0.19	0.38	4.74	0.97	-0.19	1.00	0.03	0.10	0.63	1.00	-0.03
17441	0.95	0.49	0.67	13.19	0.87	-0.49	0.97	0.01	0.35	0.32	0.97	-0.01	1.00	0.04	0.11	0.94	1.00	-0.04
17442	0.95	0.89	1.15	21.76	0.73	-0.89	0.96	0.30	0.53	7.34	0.94	-0.30	1.00	0.06	0.12	1.52	1.00	-0.06
17443	0.59	0.01	0.96	0.35	0.55	-0.01	0.66	1.13	1.63	40.62	-0.32	1.13	0.98	0.04	0.22	1.42	0.98	0.04
17444	0.91	0.56	0.90	14.77	0.81	-0.56	0.92	0.14	0.60	3.60	0.92	0.14	1.00	0.06	0.13	1.50	1.00	-0.06
17742	0.98	0.15	0.41	3.95	0.97	-0.15	0.98	0.28	0.53	7.30	0.95	-0.28	1.00	0.05	0.11	1.23	1.00	0.05
17749	0.98	0.14	0.39	3.89	0.97	0.14	0.98	0.16	0.51	4.27	0.95	-0.16	1.00	0.06	0.13	1.63	1.00	0.06
17782	0.96	1.35	1.52	29.73	0.56	-1.35	0.95	0.89	1.05	19.62	0.79	-0.89	1.00	0.01	0.11	0.19	1.00	0.01
17787	0.98	0.38	0.51	9.86	0.94	-0.38	0.98	0.22	0.40	5.76	0.97	-0.22	1.00	0.01	0.07	0.12	1.00	0.01
17789	0.96	0.02	0.42	0.54	0.96	0.02	0.97	0.18	0.41	4.81	0.96	-0.18	0.98	0.07	0.29	1.80	0.98	0.07
17790	0.96	0.13	0.47	3.59	0.95	0.13	0.96	0.00	0.42	0.10	0.96	0.00	0.99	0.02	0.17	0.55	0.99	-0.02
17822	0.98	0.73	0.82	21.67	0.85	0.73	0.98	0.30	0.42	8.97	0.96	0.30	1.00	0.04	0.11	1.29	1.00	-0.04
17854	0.97	0.59	0.78	17.69	0.81	0.59	0.97	0.27	0.46	8.20	0.93	0.27	0.99	0.01	0.15	0.41	0.99	-0.01
18028	0.97	0.86	0.99	21.06	0.77	-0.86	0.98	0.32	0.44	7.75	0.95	-0.32	1.00	0.04	0.11	0.91	1.00	-0.04
18030	0.98	0.16	0.44	4.14	0.97	0.16	0.98	0.02	0.46	0.58	0.97	-0.02	1.00	0.08	0.12	1.96	1.00	-0.08
18031	0.92	0.38	0.83	9.09	0.88	-0.38	0.92	0.49	0.88	11.85	0.87	-0.49	0.98	0.07	0.34	1.65	0.98	0.07
18032	0.98	0.79	0.85	19.64	0.82	-0.79	0.98	0.33	0.42	8.10	0.96	-0.33	1.00	0.03	0.09	0.74	1.00	0.03
18034	0.99	0.31	0.45	8.56	0.96	0.31	0.99	0.08	0.43	2.09	0.97	0.08	1.00	0.01	0.12	0.14	1.00	0.01
18035	0.98	0.57	0.66	17.08	0.90	0.57	0.99	0.31	0.39	9.23	0.97	0.31	1.00	0.06	0.10	1.74	1.00	-0.06

18038	0.98	0.19	0.50	5.07	0.95	-0.19	0.98	0.03	0.43	0.75	0.97	-0.03	1.00	0.05	0.10	1.42	1.00	-0.05
18049	0.79	0.36	1.22	9.74	0.76	0.36	0.79	0.08	1.17	2.18	0.79	0.08	0.95	0.03	0.67	0.79	0.93	-0.03
18050	0.97	0.77	0.88	17.32	0.84	-0.77	0.96	0.63	0.76	14.02	0.88	-0.63	1.00	0.06	0.10	1.23	1.00	-0.06
18441	0.99	0.97	1.07	30.53	0.70	0.97	0.98	0.56	0.62	17.59	0.90	0.56	1.00	0.10	0.16	3.15	0.99	-0.10
18443	0.97	0.63	0.90	14.84	0.88	-0.63	0.97	0.58	0.85	13.70	0.89	-0.58	1.00	0.03	0.10	0.59	1.00	0.03
18444	0.98	0.11	0.27	3.03	0.98	-0.11	0.98	0.11	0.34	3.16	0.97	0.11	1.00	0.08	0.12	2.14	1.00	-0.08
18445	0.88	0.27	0.84	8.29	0.85	-0.27	0.86	0.01	0.84	0.22	0.85	-0.01	0.99	0.22	0.29	6.76	0.98	0.22
18446	0.98	0.24	0.47	5.97	0.96	-0.24	0.98	0.19	0.48	4.68	0.96	-0.19	1.00	0.06	0.13	1.44	1.00	-0.06
18447	0.99	0.64	0.71	19.36	0.89	0.64	0.98	0.32	0.43	9.56	0.96	0.32	0.99	0.02	0.19	0.65	0.99	0.02
18448	0.98	0.79	0.96	18.86	0.84	-0.79	0.98	0.57	0.75	13.69	0.90	-0.57	1.00	0.05	0.12	1.28	1.00	0.05
18450	0.98	0.61	0.71	15.32	0.89	-0.61	0.98	0.33	0.45	8.22	0.96	-0.33	1.00	0.06	0.11	1.60	1.00	0.06
18901	0.98	0.39	0.64	10.74	0.92	-0.39	0.97	0.19	0.54	5.33	0.94	-0.19	1.00	0.15	0.19	4.12	0.99	0.15

Calibration with constant A and B coefficients (GD)

Station	Hargraves and Samani						Priestley and Taylor						Mahringer					
	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE	R2	MAE	RMSE	PE	NSE	MBE
9020	0.91	0.04	0.61	1.13	0.91	0.04	0.92	0.27	0.63	6.85	0.90	-0.27	0.88	0.07	0.71	1.68	0.87	0.07
17180	0.96	0.05	0.44	1.65	0.94	0.05	0.96	0.46	0.66	14.09	0.87	0.46	0.86	0.28	0.97	8.47	0.72	-0.28
17218	0.93	0.31	0.77	7.51	0.90	-0.31	0.94	0.56	0.88	13.36	0.86	-0.56	0.95	0.28	0.62	6.63	0.93	0.28
17219	0.85	0.43	1.42	9.87	0.76	-0.43	0.86	0.57	1.40	13.22	0.77	-0.57	0.95	0.30	0.75	7.00	0.94	0.30
17220	0.96	0.59	0.88	14.47	0.84	-0.59	0.96	0.32	0.56	7.78	0.94	-0.32	0.94	0.13	0.63	3.23	0.92	0.13
17221	0.93	0.01	0.47	0.22	0.92	0.01	0.96	0.41	0.66	12.28	0.85	0.41	0.79	0.32	1.00	9.69	0.64	-0.32
17383	0.94	1.02	1.28	26.92	0.51	-1.02	0.96	0.00	0.44	0.05	0.94	0.00	0.93	0.03	0.68	0.65	0.86	-0.03
17384	0.89	1.34	1.62	32.76	0.29	-1.34	0.94	0.36	0.61	8.76	0.90	-0.36	0.94	0.13	0.59	3.12	0.91	0.13
17439	0.83	0.96	1.36	25.38	0.47	-0.96	0.84	0.02	0.78	0.58	0.83	0.02	0.90	0.03	0.65	0.84	0.88	0.03
17440	0.83	0.71	1.22	18.04	0.66	-0.71	0.95	0.19	0.52	4.75	0.94	-0.19	0.94	0.09	0.59	2.27	0.92	0.09
17441	0.88	0.51	0.89	13.76	0.77	-0.51	0.96	0.01	0.40	0.25	0.95	-0.01	0.93	0.00	0.66	0.01	0.87	0.00
17442	0.88	0.92	1.38	22.48	0.61	-0.92	0.94	0.30	0.62	7.24	0.92	-0.30	0.94	0.10	0.61	2.36	0.92	0.10
17443	0.47	0.15	1.05	5.39	0.45	-0.15	0.65	1.12	1.63	40.56	-0.33	1.12	0.61	0.20	0.91	7.05	0.59	-0.20
17444	0.84	0.63	1.17	16.71	0.67	-0.63	0.91	0.13	0.65	3.46	0.90	0.13	0.92	0.05	0.67	1.44	0.89	-0.05
17742	0.95	0.09	0.62	2.44	0.93	-0.09	0.95	0.26	0.64	6.94	0.92	-0.26	0.95	0.17	0.59	4.59	0.93	0.17
17749	0.94	0.26	0.67	6.97	0.92	0.26	0.96	0.15	0.63	4.06	0.93	-0.15	0.95	0.20	0.59	5.47	0.94	0.20
17782	0.91	1.40	1.71	30.66	0.44	-1.40	0.91	0.89	1.15	19.53	0.75	-0.89	0.95	0.30	0.60	6.69	0.93	0.30
17787	0.95	0.36	0.71	9.17	0.89	-0.36	0.96	0.21	0.49	5.53	0.95	-0.21	0.94	0.12	0.63	2.99	0.91	0.12
17789	0.94	0.11	0.52	2.83	0.93	0.11	0.95	0.17	0.47	4.53	0.95	-0.17	0.92	0.15	0.64	3.94	0.90	0.15
17790	0.92	0.23	0.67	6.21	0.91	0.23	0.94	0.01	0.53	0.19	0.94	0.01	0.91	0.04	0.70	1.06	0.90	0.04
17822	0.98	0.89	0.95	26.57	0.80	0.89	0.98	0.31	0.46	9.20	0.95	0.31	0.93	0.06	0.68	1.93	0.90	-0.06
17854	0.97	0.71	0.80	21.55	0.80	0.71	0.97	0.28	0.45	8.50	0.94	0.28	0.90	0.09	0.76	2.72	0.82	-0.09
18028	0.92	0.89	1.19	21.71	0.67	-0.89	0.96	0.31	0.51	7.51	0.94	-0.31	0.95	0.09	0.59	2.19	0.92	0.09
18030	0.94	0.34	0.78	8.72	0.90	0.34	0.96	0.01	0.60	0.34	0.94	-0.01	0.95	0.08	0.61	1.94	0.94	0.08
18031	0.86	0.27	1.00	6.41	0.83	-0.27	0.89	0.48	0.95	11.49	0.84	-0.48	0.92	0.29	0.72	7.02	0.91	0.29
18032	0.97	0.83	0.95	20.73	0.77	-0.83	0.97	0.31	0.45	7.79	0.95	-0.31	0.95	0.15	0.59	3.63	0.91	0.15
18034	0.95	0.46	0.75	12.57	0.90	0.46	0.96	0.09	0.57	2.37	0.94	0.09	0.94	0.11	0.61	3.11	0.93	0.11
18035	0.95	0.71	0.86	21.16	0.83	0.71	0.97	0.32	0.48	9.55	0.95	0.32	0.93	0.08	0.69	2.53	0.89	-0.08
18038	0.93	0.14	0.76	3.82	0.89	-0.14	0.95	0.02	0.57	0.41	0.94	-0.02	0.94	0.04	0.64	0.96	0.92	0.04
18049	0.76	0.56	1.36	14.94	0.71	0.56	0.77	0.08	1.22	2.27	0.77	0.08	0.83	0.08	1.10	2.16	0.81	0.08
18050	0.93	0.69	0.95	15.46	0.81	-0.69	0.93	0.62	0.86	13.82	0.85	-0.62	0.94	0.18	0.61	4.03	0.93	0.18
18441	0.99	1.15	1.20	36.41	0.62	1.15	0.98	0.56	0.63	17.71	0.90	0.56	0.90	0.18	0.81	5.79	0.83	-0.18
18443	0.93	0.56	1.08	13.23	0.82	-0.56	0.95	0.58	0.95	13.57	0.86	-0.58	0.96	0.31	0.61	7.23	0.94	0.31

18444	0.96	0.07	0.43	1.93	0.95	-0.07	0.98	0.12	0.31	3.28	0.97	0.12	0.95	0.08	0.74	2.34	0.84	-0.08
18445	0.86	0.37	1.02	11.55	0.77	-0.37	0.83	0.00	0.91	0.04	0.82	0.00	0.94	0.26	0.63	8. 05	0.91	0.26
18446	0.96	0.14	0.62	3.48	0.93	-0.14	0.97	0.18	0.54	4.60	0.95	-0.18	0.95	0.11	0.58	2.78	0.94	0.11
18447	0.97	0.79	0.87	23.82	0.83	0.79	0.96	0.32	0.53	9.70	0.94	0.32	0.90	0.05	0.69	1.59	0.89	0.05
18448	0.95	0.78	1.12	18.65	0.78	-0.78	0.96	0.57	0.81	13.54	0.88	-0.57	0.97	0.30	0.56	7.08	0.94	0.30
18450	0.96	0.61	0.86	15.41	0.84	-0.61	0.97	0.32	0.51	8.07	0.94	-0.32	0.95	0.23	0.59	5.73	0.92	0.23
18901	0.95	0.45	0.90	12.40	0.84	-0.45	0.95	0.18	0.65	4.98	0.92	-0.18	0.95	0.24	0.58	6.59	0.93	0.24